Popular Science

MONTHLY Founded 1872

September
1927
25 cents

Amazing New Aviation Developments,

You wouldn't stuff yourself tonight —then go hungry all next week!

DON'T expect your radio storage battery to bring in programs loud and clear when you work it day after day without replenishing the power. Keep the battery strong and active by feeding it regularly—with a Rectigon Home Charger.

Charge at trickle or high rate—Rectigon does both.

With the Rectigon you can get a steady "trickle" to replace "A" power as you use it. In case of heavy drains due to prolonged use of the set, by a mere rearrangement of the leads you charge "A" or "B" batteries quickly, at a heavy rate. Either way, when you turn on your radio, you have power to spare. There are no acids or chemicals with Rectigon — no moving parts. You just attach the leads and plug into the light socket. It will charge your automobile battery the same quiet, "no trouble" way.

Rectigon, the many purpose charger, at good radio stores.

WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, EAST PITTSBURGH, PENNSYLVANIA
OFFICES IN ALL PRINCIPAL CITIES • REPRESENTATIVES EVERYWHERE • TUNE IN WITH KDKA—KYW—WBZ

BESIDES Rectigon for better battery charging, Westinghouse also makes Micarta Panels and tubing for better insulation, and power testing instruments for better reception.

Rectigon Home Charger for radio and automobile storage batteries.

Westinghouse

Scientists Perfect Light Socket Power

OUT of the wizardry of retorts and test tubes, born of molten temperatures far beyond the conception of the average man, scientists have developed a new method that makes possible light socket power. Light socket power as dependable as your own house current, that demands no more attention than your electric iron, sweeper, or toaster.

Scientists, led by Professor S. J. M. Allen, Ph. D., of the Post Graduate College of Engineering, University of Cincinnati, working with metals and minerals in temperatures and electric furnaces of unheard-of proportions after years of experimenting, succeeded in re-arranging the entire atomic structure of copper, thus converting an ordinary conductor material into this new metal, now known to the scientific world as Kuprox.

The Replacement Unit, a series of simple Kuprox metal discs, rivated together.

A tiny disc of Kuprox, scarcely as large as a half-dollar now does the work that formerly required charging bulbs, noisy vibrators, and ruinous jars of acid and electrolyte.

Kuprox is now offered in stores of radio dealers the country over in many forms. Units, delivering radio "A" power, radio "B" power, and compact single units from which all radio power necessary for the operation of a set, is obtained are among the new items in which this new rectifying metal is used.

How the Kuprox Replacement Unit replaces the acid jar on trickle chargers.

One of its most interesting forms is the Kuprox Replacement Unit, consisting of a series of several Kuprox Discs, with which to replace the acid jar and charging unit on all existing electrolytic trickle chargers and power units. With this unique replacement unit, retailing for only $4.50, it is but the work of a few minutes to do away with all the bothersome watering and other attention that has been necessary to keep a trickle charger functioning. Two simple binding post connections are all that are necessary. Merely disconnect the present acid jar from the transformer of the trickle charger, throw it away and connect the same two leads to two binding posts on the Kuprox Replacement Unit. Thus any electrolytic charger becomes absolutely dry. In addition to eliminating all the attention necessary with the ordinary wet charger, this replacement unit of course does away with the acid fumes and the possibility of ruined clothing and furniture. The Replacement Unit also gives a great deal higher charging rate, resulting in greater operating efficiency of the battery.

WHAT IS NEW THIS MONTH

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Models

New Devices for the Home

New Processes and Inventions

Radio

Unusual Facts and Ideas

For the Home Builder

Hints for the Mechanic

Ideas for the Handy Man

More Than 250 Striking Articles in This Single Issue
Cover from Every Angle the Latest Developments
in the World of Invention and Discovery

Why PUBLIC UTILITIES Are a *Good* Investment

By WALLACE AMES, *Financial Editor*

THE following letter to POPULAR SCIENCE MONTHLY brings up an interesting subject.

"WALLACE AMES, *Financial Editor*,

Dear Sir:

"I have been interested in reading your recent articles on public utilities and their investment value. Undoubtedly the utilities have established some wonderful records in the past few years, but how is this going to affect their continued future growth? For instance, I read somewhere that the number of new homes wired for electricity is on the decrease. Can I expect that the business and the earnings of electric light and power companies will continue to increase?"

IT IS true that 1924 was the peak year in number of newly wired homes. 1,783,000 homes were wired that year as compared with 1,122,550 in 1916, according to *Electrical Merchandising*. But there are many other factors that will affect the future of public utilities as a form for investment.

The 58% or 60% of America's homes which have already been wired for electricity include mostly homes in the larger towns and cities, places having 1,000 population or over. There are still a big proportion of the homes in villages, hamlets and farms to be wired for light and power.

The "super-power" development, which in layman's English means the interconnecting of generating stations is steadily making it possible to reach more and more of these homes in thinly settled districts. It will not be long before electricity will be available to almost every home in the United States. This means there will be a satisfactory continuance in the number of newly wired homes.

But let us assume that the 1924 record will never be duplicated. It does not follow that there will be a let-up in the business done by the utilities.

As we said in our article in the August issue of POPULAR SCIENCE MONTHLY, the average home consumption of electric current is now only $17.89 per year. The goal of the utilities in this branch is $85 a year.

To begin with, home owners are being educated to have their houses more completely wired. The number of outlets per home is on the increase. In addition to the more extensive use of table and floor lamps, in addition to wall and ceiling lights, plugs are being installed in kitchens, laundries, bath rooms, etc., so that electrical appliances may be more extensively used.

This table of figures from *Electrical Merchandising* will indicate how great is the future market for electric current in the 16,000,000 homes which are now wired.

74.9% of homes are as yet without an electric toaster;
62.9% have no vacuum cleaner;
97% have no electric range;
73.3% have no electric clothes washer;
98.3% have no electric ironer;
73.9% have no electric fan;
97.6% have no electric refrigerator;
86.3% have no electric heater;
95.3% have no electric cooker.

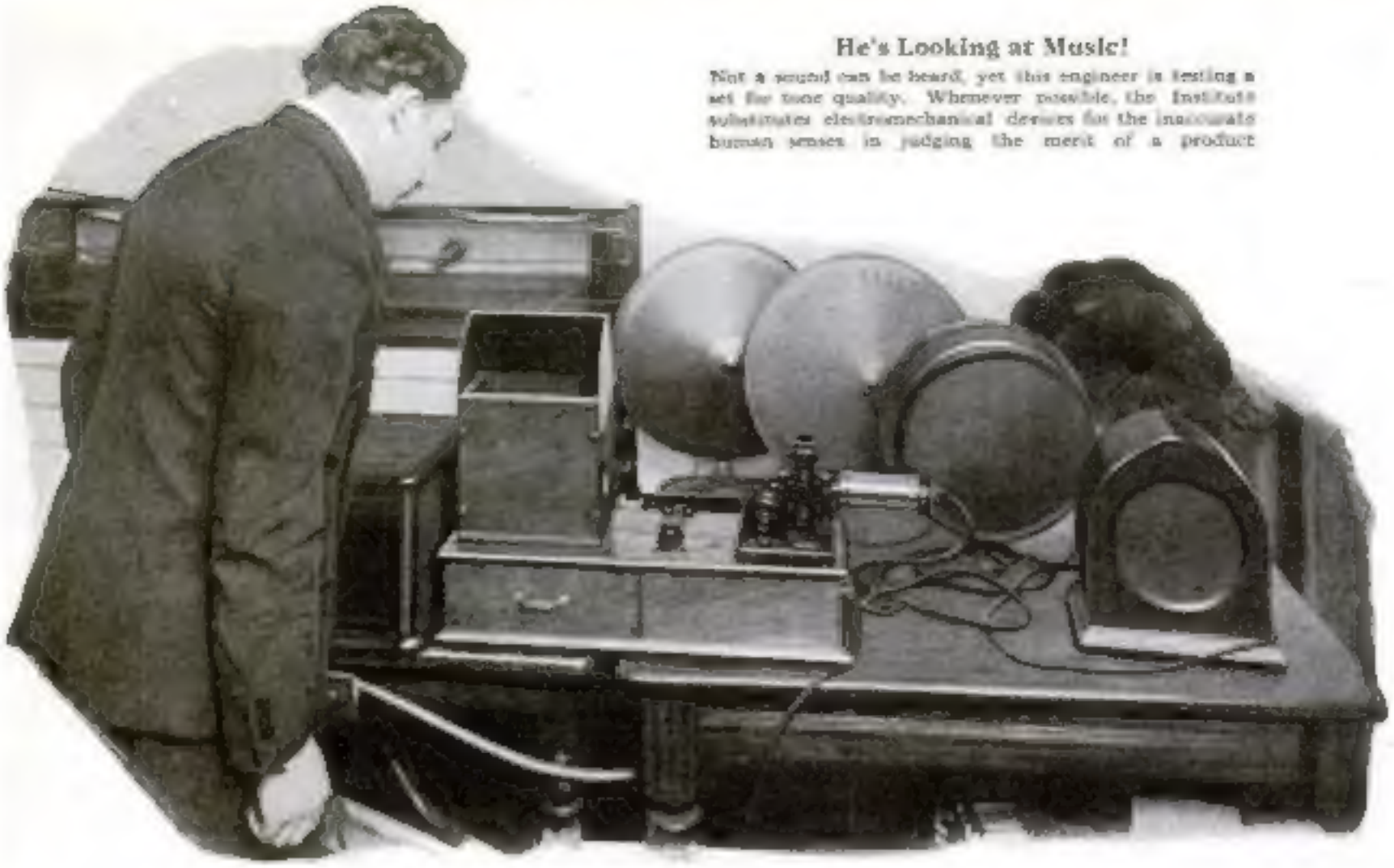
BOTH manufacturers of electric appliances and electric light and power companies are rapidly educating the public to the wider use of labor-saving and comfort-producing electrical devices. And a comparison of wages and cost of living, shows that the public is able to afford more electrical conveniences.

In 1913 wages and cost of living were both represented by 100. In 1926 the cost of living figure had risen to about 175, but the wage figure had mounted to about 190, showing a wide purchasing margin which did not exist in 1913.

The laborious work of the farmer is still a subject of popular discussion and still one of his grievances. In the early days of electric light and power development it was not possible for central stations to transmit current far enough from their generating plants to make it available to the farmer and the resident of the small village. But that situation is being overcome and the future will witness electric farms which will compare favorably in modern conveniences with the electric home so common today.

We will soon see much of the hand labor of the farm done by electricity. Irrigation is already a big source of electric revenue. The day is coming when electric power will be commonly used for incubators, illumination for the increase of egg production, shelling and cleaning numerous crops, threshing, cream separating, running grindstones, silage cutting, milking, churning, operating lathes, drills, pumps and other machinery, horse and sheep clipping, and sawing, refrigeration, sterilization and all the household uses now common to the cities.

(Continued on page 5)



He's Looking at Music!

Not a sound can be heard, yet this engineer is testing a set for tone quality. Whenever possible, the Institute substitutes electromechanical devices for the inaccurate human senses in judging the merit of a product

DID YOU EVER *SEE* TONE QUALITY?

YOU may not want distance, you may not even be particularly interested in getting a very selective receiving set, but you certainly *do* want true tone quality.

The Popular Science Institute has been able to substitute the eye for the ear in judging this quality.

The tone quality of a radio set is really a measure of the faithfulness with which it reproduces in the form of sound the electrical impulses that it receives from the broadcasting station by way of the receiving antenna or loop. In carrying out this function in a perfect manner, the following characteristics are of importance:

1. Its ability to amplify with equal effectiveness all the audible frequencies that compose music and speech.

2. Its freedom from self-generated stray oscillations which combine with and distort the form of the received electrical impulses.

3. Its ability to maintain the relative strength of the electrical impulses while they are being detected and amplified.

The ideal set, from the standpoint of absolute perfection, should show no departure from perfect in any of these characteristics throughout the range of broadcast wave lengths in the radio-frequency end and within the audible range in the audio end.

No radio set is absolutely perfect. Its relative quality depends on how much it deviates from perfection. As no two ears are the same, ear tests cannot be reliable. By the Institute's method, the performance of the set is translated into forms that will affect a visual meter so that a pointer moving across a dial is substituted for the erratic and uncertain human ear.

Of the imperfection to which the radio set may be subject, the presence of any stray audio- or radio-frequency oscillations is most harmful because they are sure to result in distortion. Consequently, absolute freedom from such distortion is necessary.

The test arrangement for obtaining the over-all audio-frequency characteristics is of particular interest because in one single rapid test it reveals the accumulated effect of the small distortions that may be caused by the various parts of the set or circuit.

This arrangement consists of a perfect miniature broadcasting station capable of transmitting for test purposes an unvarying test signal on any desired wave length and modulated at any desired frequency in such a way that the modulation can be changed through the entire audible scale without altering the degree of modulation or the intensity of the signal.

The set is exactly tuned to this transmitter and the output of the set is connected to a measuring system that is the exact equivalent of what a perfect loudspeaker would be if such a perfect mechanism were obtainable.

The modulation of the transmitting wave is then varied through the audible range and the response of the receiving set is recorded. Throughout the test, the transmitter is kept under constant observation by means of a cathode ray oscillograph to make certain that the transmitted wave used in the test is of uniform strength and that the modulation is constant.

Using the figures obtained in this way, the engineers of the Institute are able to plot a graphic curve which represents a perfect picture of the over-all efficiency of the radio set. It is not a case of forming an *opinion* regarding a set's tone quality, but of determining *facts* by actual measurements.

A 20-page booklet on buying, installing and operating a radio outfit, that also contains a list of reliable tested equipment, can be secured from Popular Science Institute, 250 Fourth Ave., New York City, for 25 cents.

When You Switch on Anything Marked

Day-Fan

You Get What You Want!

THAT means just what it says, when you're talking about the Day-Fan Radio, because this year *for the first time in radio history*, these fine receivers get their power through a silent little *motor and a generator* supplied with the receiver! How's that for a great advance? No Batteries! No Eliminators!

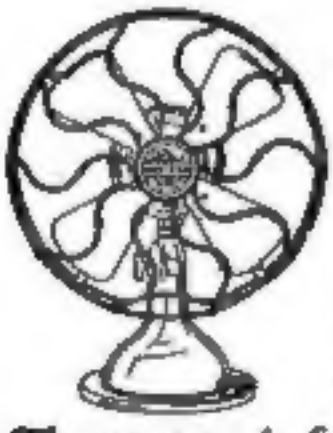
Never any worry about "will I get what I want!" Never any worry about run-down equipment. Go away and leave your radio for six months—when you come back switch it on full flood o'power, as easy as your electric fan. Tremendous volume when you want to dance—beautiful quality always.

Day-Fan, the radio receiver used by great broadcasting stations to listen to their own programs (list on request), still stands alone. If you want fine battery powered sets, we make them from $65.00 up. If you want the new light socket AC tube set, we make that too. Whatever you want in radio this year, ask a Day-Fan dealer for it.

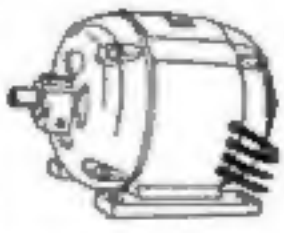
The New Day-Fan receivers illustrated are (at top) the Day-Fan Junior, battery operated 6-tube, $65.00; the Motor-Generator powered De Luxe (lower left); and the 6-tube Day-Cee Six (AC Tube set operated from light socket).

RADIOS

FANS



MOTORS



In addition to Radio Receivers as illustrated above, Day-Fan makes the other products shown on this page. These include the popular types of electric fans driven by the powerful Day-Fan motor for long life and efficient service and the small motors themselves, such as are used by prominent manufacturers of electric refrigerators and household appliances.

PREMULGORS

CLEANERS

The Day-Fan line includes also Premulgors, which are motor-driven blenders and emulsifiers for use in drug stores, kitchens, hotels and restaurants, and the famous hand size vacuum cleaner. This handiest of household helpers weighs only three pounds, is the size of a whisk broom, and costs little. It owes its efficiency to the famous Day-Fan motor. Send for circular about it.

The coupon is for your convenience. Fill it out and send it in, or drop a post card

DAY-FAN ELECTRIC COMPANY
DAYTON, OHIO

Send me information regarding the items checked:

☐ Radios ☐ Motors ☐ Vacuum Cleaners ☐ Fans ☐ Premulgors

Name _____

Address _____ P. S. 1

This seal on a radio, tool or oil burner advertisement signifies the approval of the INSTITUTE OF STANDARDS. See page 6.

Popular Science MONTHLY

SEPTEMBER, 1927 SUMNER N. BLOSSOM *Editor* VOL. III, NO. 3

America Takes to the Air

With Nine Transport Companies Carrying Passengers, 4000 Landing Fields in Operation and 7300 Miles of Lighted Airways under Construction, a New Flying Era Is Beginning

By FRANK PARKER STOCKBRIDGE

I PARKED my car on the edge of the prairie, a dozen miles back from Lake Michigan, and looked at the dashboard clock. It was five-fifteen in the morning and the sun was just struggling through Chicago's dawn. That particular stretch of prairie looked like any of the million square miles lying around in that region, except for the row of sheds that lined its edge, but to me it was the most interesting spot in America. For this was Maywood Field, the heart and center of the United States Air Mail Service. And around this nucleus of the Air Mail America is just beginning the development of a system of aerial passenger traffic which is already challenging Europe's supremacy in commercial aviation.

Two important things have happened, since the first of last May, to make it a safe prediction that in another year, perhaps sooner, traveling by air will be as popular in the United States as it is today in Europe.

First, the United States Government has gone out of the airmail carrying business.

Secondly the people of America have become at last "air conscious."

If you doubt that last statement look at your morning paper and count the headlines over aviation news. And the significance of the other fact just cited I shall try to make clear.

There weren't many signs, I'll admit, of any such nation-wide interest in aviation, that morning at Maywood Field. Two or three spectators, like myself, passing the time of day with the mechanics working on planes in the hangars or out in the field. A few postal clerks sorting and sacking mail. A group of keen-eyed, hero-worshiping youngsters inspecting the machines in which they were presently to fly to the four winds, or gossiping among themselves and looking forward to the first day of August, the date scheduled for the Post Office Department to turn over the last of its air routes to private contractors.

A big monoplane rolls out of a hangar. The pilot who is to fly it to Detroit at eight o'clock steps in, roars across the prairie and rises for a test spin. The plane which will start for New York at the same hour is still sleeping in its shed. The Detroit flyer lands, and the sound of his engine has hardly ceased before out of the rising sun emerges the black speck of the night mail from New York. Literally, it has come only from Cleveland, this plane which circles now to a perfect landing. It left Cleveland at 4:15 this morning, after taking the mail from another plane which left the East at 9:35 last night.

The pilot from Cleveland is hardly out of the cockpit before another plane is heard, this time from the West. "Here comes Omaha!" cries a mechanic. Husky porters are carrying mail sacks from the New York plane to a waiting Post Office truck and to other planes waiting for their starting signals. The Omaha plane, finishing the last leg of the San-Francisco-Chicago transcontinental route, glides down.

THREE planes stand waiting, pilots in their seats, mechanics standing by. Porters dump mail sacks from the new arrivals into each of them. Then, sharp on the dot of five-fifty, all three taxi down the field, rise and wheel away toward their destination: one to St. Louis, another to Kansas City, where another plane will take on the mail it carries for Dallas and intermediate points, and the third for Minneapolis and St. Paul.

That is the daily morning drama of the Air Mail, enacted at Maywood Field with variations and additions ever since May, 1919, when the Government, after a brief experiment with a New York-Washington air mail service in 1918, established the first link of the Transcontinental Airway, from Cleveland to Chicago. Five of the eighteen commercial airways established by the Government center here at Chicago now. And over these eighteen air-

Leaders in America's advance in aviation. Left to right: Charles L. Lawrence, designer of Wright Whirlwind engine which drove three American planes to Europe; Anthony Fokker, designer of Fokker monoplane used in flights to North Pole, France and Hawaii; Charles H. Colvin, designer of earth inductor compass which guided ten flyers

ways, totaling more than 10,000 miles and crossing the country in both directions from coast to coast and from Canada to Mexico and the Gulf, 194 airplanes in the year 1920 flew 4,474,772 miles. In that year these planes carried 433,649 pounds of mail and there was but one mortal accident to all of these planes.

That sort of thing has been going on for eight years, but the public has displayed no great interest in flying until now. The air mail service as such meant nothing to most of the people.

When the Government decided to go no farther in the operation of its own mail planes and contracted with private companies for carrying air mail, as it does with the railroad companies for carrying ordinary mail, passenger transportation by air in America began to look up a little; for the contracting companies carrying mail were permitted to carry passengers and express matter on the same trips. People began to ride with the air mail.

FEW realize that in the year 1926 576,567 passengers paid their fare and were carried in airplanes for longer or shorter rides, in the United States. Besides these 94,353 passengers traveled "dead-head," according to figures compiled by William P. MacCracken, Jr., Chief of the Division of Civil Aeronautics of the Department of Commerce, to whom every airplane operator in the United States is now required to report.

The biggest passenger business of the year was done by the line operating between Philadelphia, Washington and Norfolk during the Sesquicentennial Exposition, from July to December. It carried 3,095 passengers in five months. As many others were carried to their destinations all over the United States, along with mail and baggage. The rest of the air passengers in 1926 flew in one or another of the 1,036 commercial planes, operated by approximately 600 individuals or companies, as "taxi" planes, on sightseeing tours, or in exhibition flying, advertising stunts, aerial photography, plant-spraying and so on.

These non-scheduled flights aggregated 18,746,040 miles. Add to that the scheduled flights already mentioned, of 4,474,772 miles, and another 89,940 miles flown on specially-arranged tours, cross-country contests and exploring expeditions, and we have the respectable total of 23,310,354 miles of airplane flights by strictly non-military planes in 1926. And when you add again the 25,133,640 miles flown during the same year by Army, Navy and Marine Corps pilots, making some 48,443,994 miles of flying in the United States in the latest complete calendar twelvemonth it looks as if America were then pretty well up in the air.

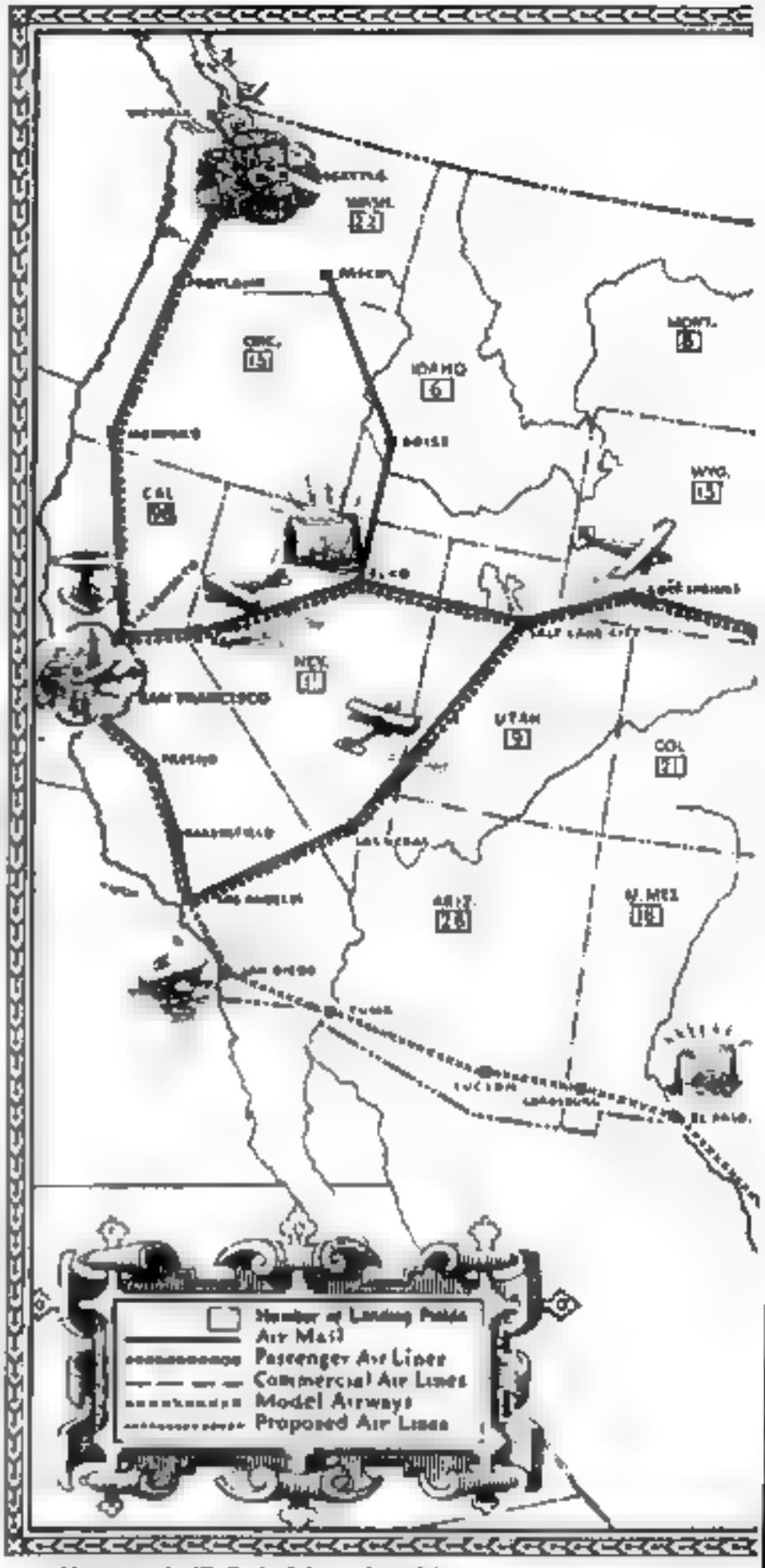
BUT we weren't as compared with Europe. Aviation is America's own game, but Europe has been beating us at it ever since the war. Only a few months ago, in fact, the outlook for commercial aviation in the United States seemed almost hopeless. The Government had refused to consider a subsidy for flying. Commercial aircraft operators were having difficulty in getting capital and in inducing young men to go into training as airplane pilots. Even the Army and Navy were not getting nearly enough recruits for flying service.

Then Russell Maughan made his coast-to-coast non-stop flight. *That* got newspaper headlines and caused a ripple of subconscious popular interest in flying. Later when Commander Byrd flew across the North Pole the ripple came a little nearer the surface of the public's consciousness.

Then, one day last May, an air mail pilot named Charles Lindbergh casually flew from San Diego to Paris, making short stops en route at St. Louis and New York. *That* made a big splash. People everywhere began to wake up to the possibilities of flying. And when Chamberlin and Levine, and then Byrd and his crew, followed Lindbergh the whole popular view of aviation in America was changed.

THAT was what I meant when I said that America had at last become air conscious, in the sense that Europe has been air conscious for several years. Instead of nobody wanting to fly, now everybody, broadly speaking, wants to fly.

From all over the country in recent weeks have come announcements indicating the expansion of aviation activities. New air mail routes and airways. Capital coming forward to invest in airplane manufacture and operation. More important than these, the firing of America's youth with the desire to fly like Lindbergh.



Map drawn by W. Parke Johnson from data supplied by the U. S. Government agencies

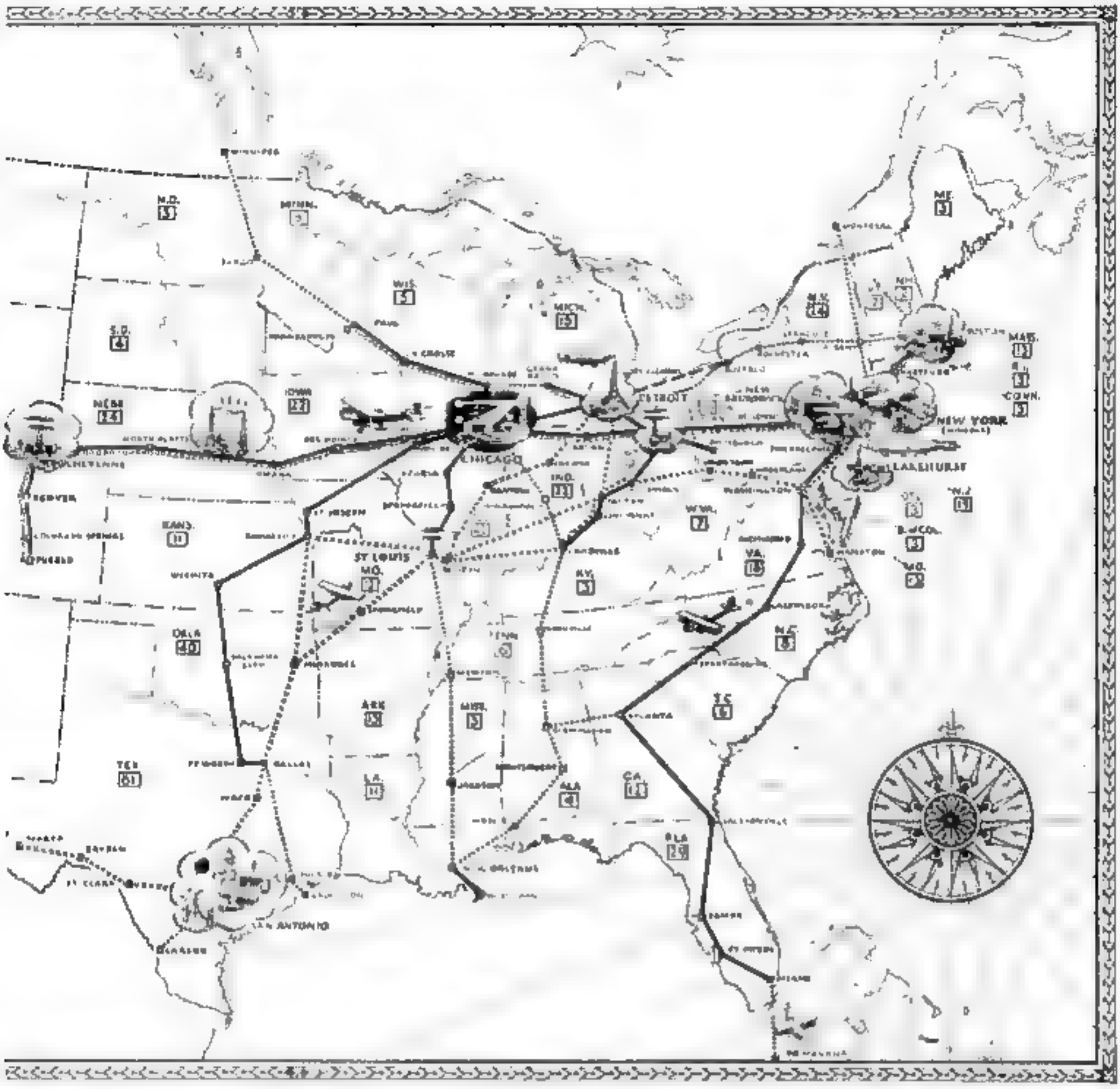
That boy did for aviation in America what Mussolini is trying to do for aviation in Italy by offering everybody a free ride in a Government airplane. Mussolini is trying to make the Italian people air conscious; Lindbergh has done that for America. Aviation schools are overwhelmed with applications for instruction. Instead of paragraphs about flying accidents, newspapers print pages of constructive information about the present and future of aviation.

No wonder Secretary Hoover has predicted that before the end of 1927 the commercial aviation mileage flown in the United States may be expected to reach a total within 25,000 miles a month of that being flown in all Europe.

Those figures of passengers carried in American airplanes last year may have seemed impressive, but consider them again for a moment. Out of nearly 730,000 passengers, only about one percent, or around 7,000, went by airplane because they wanted to get somewhere. The other 99 percent flew as a stunt. That has been the American way of looking at aviation; as a rather hazardous stunt, to be indulged in for fifteen minutes or so just to see what the sensation of flying is like. In Europe virtually all passengers fly because they want to get somewhere in a hurry.

Precisely what the Government has done, is doing and has pledged itself to do for the furtherance of commercial aviation has been clearly expressed by Secretary Hoover, in whose Department of Commerce is now vested control of all non-military flying, including the air mail.

"The thing immediately necessary in the development of commercial aviation," said Mr. Hoover, "is airports or terminals, which should be provided by the principal



This map shows the network of airlines already existing in the United States with those proposed, which within a short time will provide America with an air service that will rival that of Europe—due in a large measure to the advance of interest following the successful transoceanic flights

municipalities in the same way coast cities provide docking facilities. Such suitably equipped landing fields as are necessary will make a city an airport in the same way that docks and shipping facilities make them seaports. Air routes can scarcely be expected unless there is a chain of airports, where supplies, shelter conveniences and storage for mail and express are available. While cities are providing the airports, the Government will be providing the emergency landing fields where needed, mapping the air routes, licensing pilots, supplying air charts, and providing lighthouses for the air, as it does for mariners. These things the Government is now doing, as well as developing forms of direction finding, enabling the maintenance of the service in all sorts of weather.

"We will not develop a passenger service, or even a safe postal and express service, unless we apply such safeguards as are now in force under the law. There must be rigorous inspection of planes and the licensing of pilots must be vested in the Federal Government, as it now is. If you study accidents in the United States you will find that an extraordinarily high percentage of them are the result of planes having been flown that never should have been allowed to leave the ground, or of planes being piloted by incompetent persons. There must be an assurance of rigid inspection and of competent operating personnel if we are to establish confidence in aerial navigation. Every ship that departs from our shores is inspected as to safety of construction and equipment; every officer has been tested as to his efficiency."

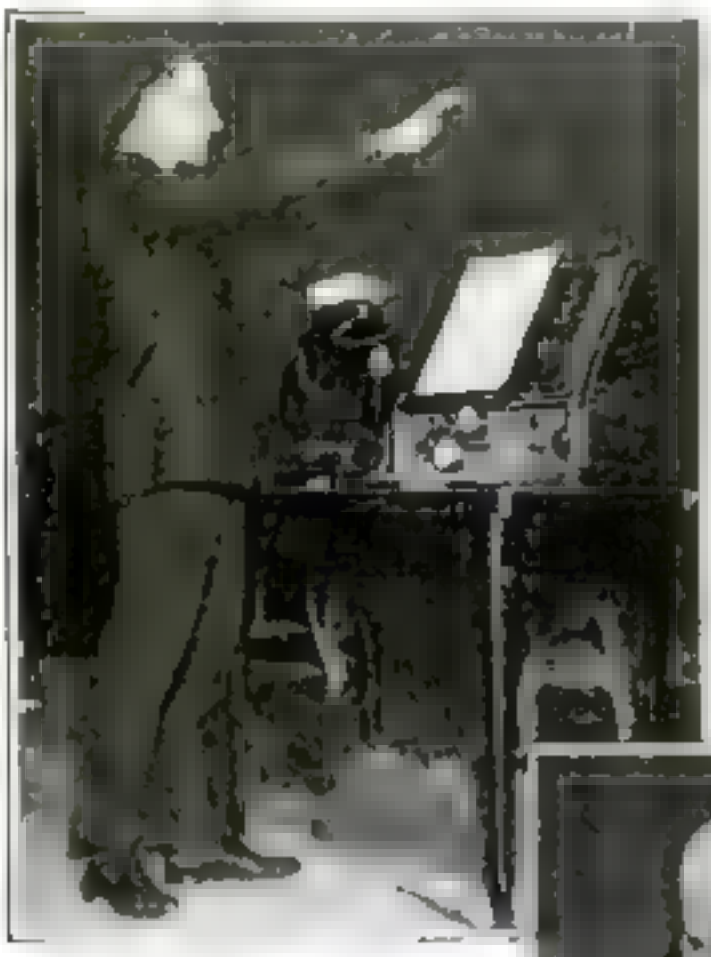
Enough progress has already been made toward completion of the program Mr. Hoover outlined to justify the declaration of the Department of Commerce that within a short time the Federal Government will have provided 9300 miles of airways with emergency fields, 7300 miles of these airways lighted and, with Chicago as the hub, connecting twenty cities with a population of 25,000,000.

There are now in existence more than 4000 landing fields in the United States, listed at the Department of Commerce. One thousand of these are included in the "officially approved" classification. Two hundred and seven cities have already provided municipal airports, ninety-three more cities have begun arrangements to provide them.

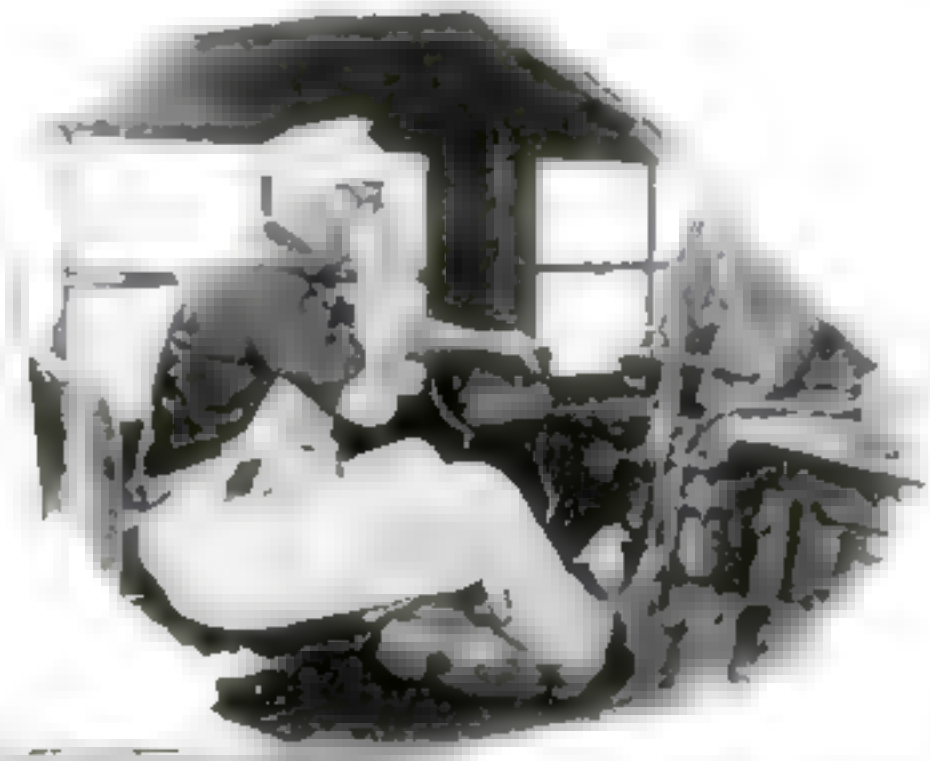
The difference between an airport and a landing field is largely a matter of equipment and location. (Continued on page 120)

Our Amazing World

A Wave of the Hand Starts Steel Mills or Produces Music Baseball Games at Night Other Strange Sights

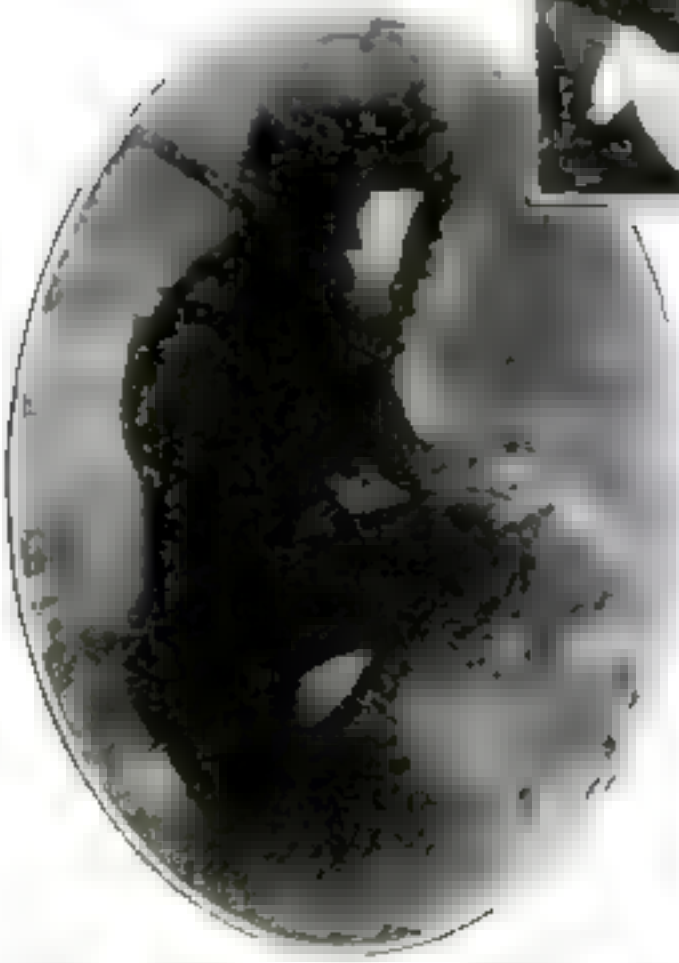


By waving his hands over a remarkable sound producing instrument, M. Termens, French inventor, claims he can reproduce any voice or musical instrument. Sensitive electrical circuits, governing pitch and volume, are affected by the nearness or fornese of his hands



Flags and hand signals in the operation of long freight trains will be supplanted by radio if the method illustrated above proves dependable. The engineman is seen communicating with the brakeman in the caboose, more than a mile away. A short wave transmitter is used. Test tests of the apparatus were successful

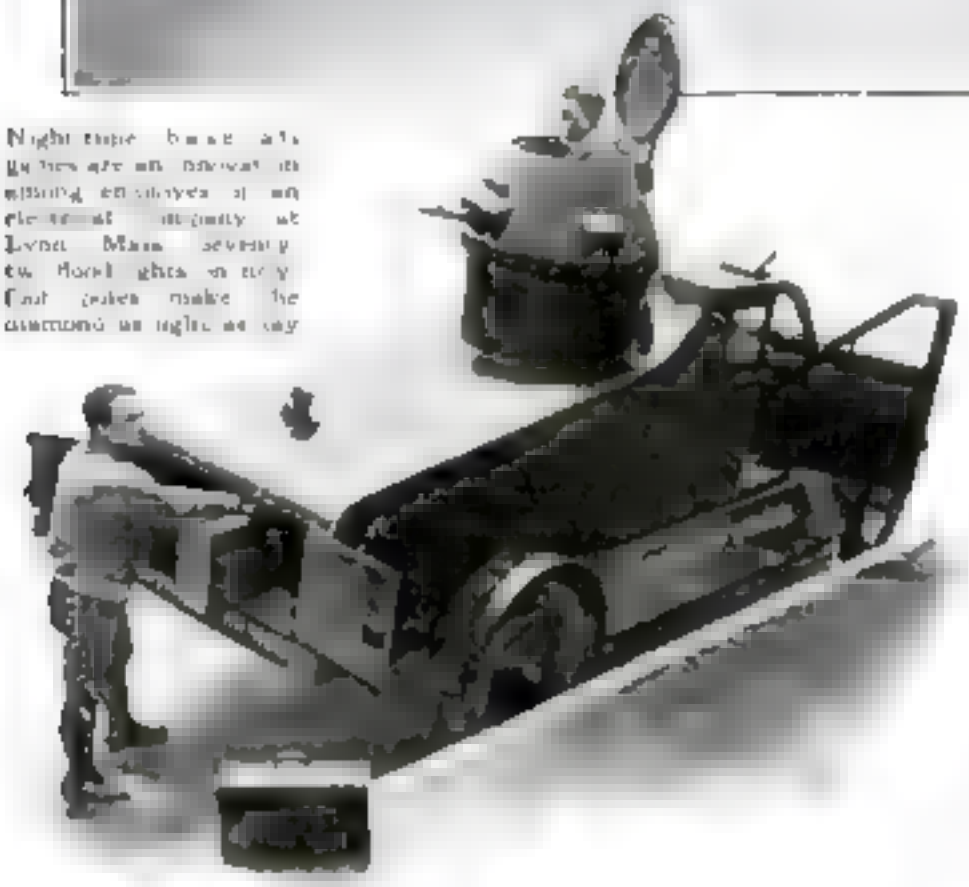
Seated at his desk in New York City, Judge Elbert H. Gary, U. S. Steel Corporation chief, left, recently set a motion new steel mills near Pittsburgh, Pa., simply by moving his hand above a silver lined glass sphere. This released a minute electrical charge from a sensitive "grid glow" tube. By radio relay this charge controlled the distant machinery

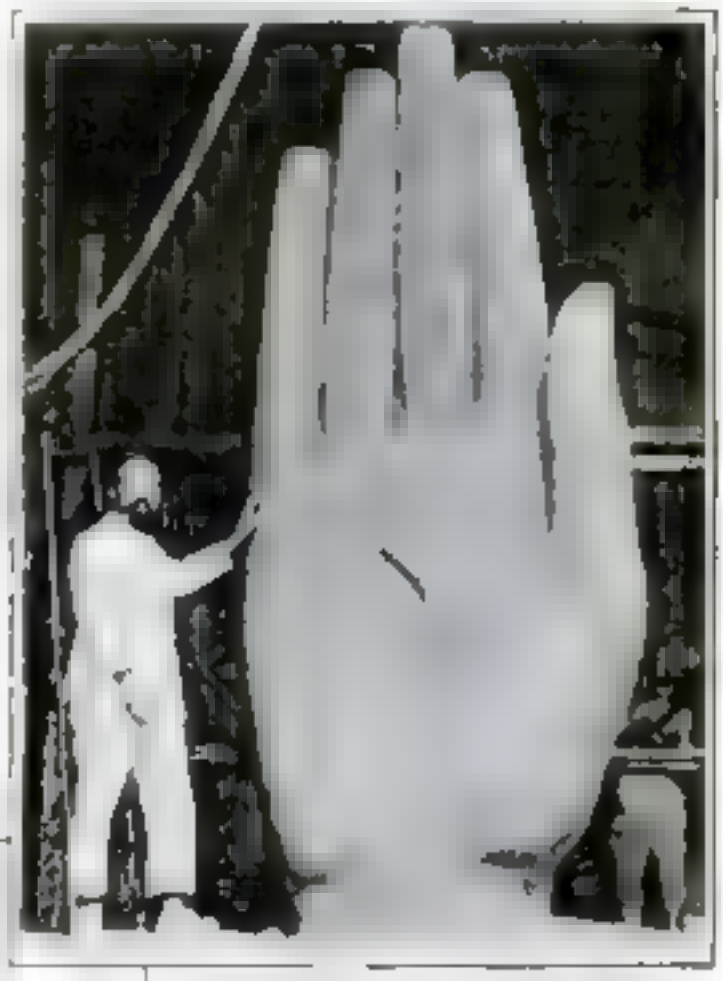


Wearing special diving helmet and bathing suit, William Beebe, noted naturalist-explorer, recently jotted down on a zinc plate his observations while thirty feet under the sea near Port-au-Prince, Haiti

"Get close to the soil and never grow old," says Charles M. Schwab, Bethlehem Steel Corporation head, shown here practicing as he preaches on his 1700-acre Pennsylvania farm. The magnate is tilling the land with a tractor, as he plans to do much of the time while he makes the country place his chief residence. "Immergrun," as it is called, has blooded livestock, gardens and golf links and much of the land is under cultivation

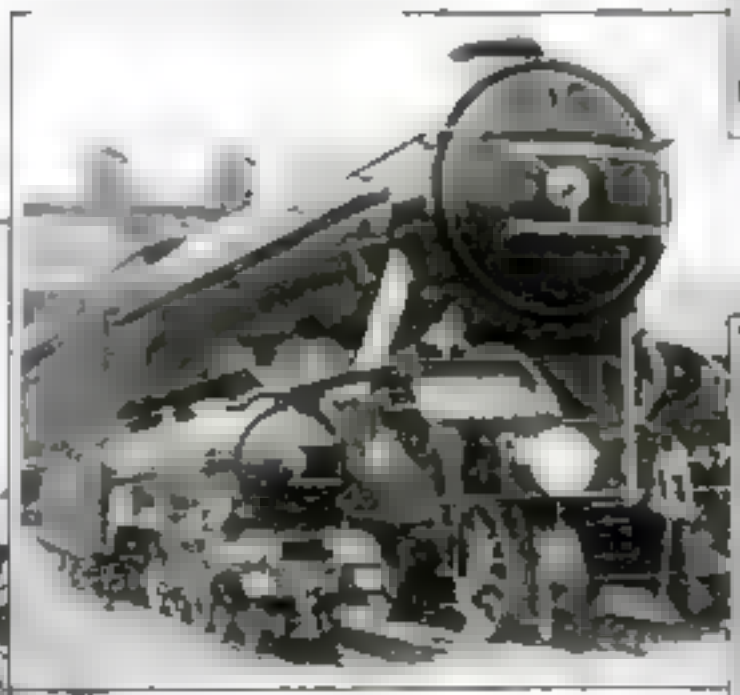
Night time bombing planes will be guided over all highways in missing 48 minutes of an electrical beam sent out from Lympne, England, airport. Seventy-five flood lights on each side of the beam make the illuminated air lights as easy





This is a head, carved as an intended part of the gigantic statue of Christ being made by Paul Landowski. Parisian sculptor. It is to be erected on Mount Corcovado, overlooking Rio de Janeiro

All the action in this new air fire battle is vintage with the exception of having real danger sight. The gunner is equipped with machine gun that sights in any windows. The two have bullet proof suits and cannot be injured by bullets



The giant beast at the end is "pop" shown with it are the Flying Scotsman famous on the London and North Eastern Railway and a miniature of it built for a narrow gage line in Kent. The big fellow weighs 150 tons the other weighs only eight. The pup is about a third of the daddy's size

The giant camel on the right, photographed with a wild ass of Persia has been mistaken for the smallest grandfather in the world. He is a pygmy, although his race are not dwarfs and some are unusually tall

Enough telephone apparatus for an office building was put in the Summer White House in South Dakota to keep President Coolidge in touch with Washington and the nation. Girls in the Chicago plant of the Western Electric Company are seen at right, checking out some of the great bulk of equipment needed

Schedule Or—

Skill and Pride on Trial as the Limited Thunders in the Race against Time

By

LEO F. CREAGAN

Illustrated by H. M. D. Rundle

Marley [illegible] on the [illegible] station, [illegible] with [illegible] hour [illegible]

NEWS of the appointment of Barnard Sylvester as executive director of transportation of the Atlantic and Pacific Railroad reached Daniel Marley in his office at Kingston Junction a moment after the superintendent's arrival for the day. A Montreal newspaper, heavily blue-penciled where the item appeared, caught his eye before he had time to indulge in his morning ritual of toying with the row of push buttons on his desk. As he read and reread the announcement he was conscious of a feeling of distinct apprehension.

Now, in ordinary circumstances the addition of one more name to a railroad's official roster would have had little effect upon the personnel, particularly to a man like Marley who, by the sheer force of his dynamic personality, had forged his way in five years from a lowly place as "king swipe" of a track gang to a superintendent's fine chair. But Marley had not forgotten the bitter humiliation attending a forced resignation two years before. No matter if subsequent events had returned him to his former place of grandeur he could not forget that a temporary change in the management high up had brought about his official downfall and had woefully wounded his pride. And the man who had literally wrung his resignation as superintendent from him had been a stranger like this Barnard Sylvester person, one who could not know of the part he had played in building and maintaining what he fondly believed to be the finest link in Canada's transcontinental railroad chain. Thus it might happen again, for Sylvester's coming had been as sudden and as secret as that of his predecessor two years before.

Marley stared at the paper with glazed eyes, but the words came to him clearly. Mr. Sylvester was no stranger to the people of Montreal, it read. He had come from the P. & C., a road reputed to be the Atlantic and Pacific's strongest competitor for western business, and the newspaper hinted at important developments in the near future. To Marley, alone in his office, the promised developments could have but one meaning—his resignation. So certain of it was he, that he felt the future would be too long to wait for the dreaded news. "An' what is an executive director of transportation?" he asked, when General Manager Lemoel C. McCutcheon answered his long distance telephone call.

"OH, HELLO, that you, Daniel?" McCutcheon's voice sounded friendly and almost reassuring. "An executive director of transportation, if you refer to Sylvester's appointment, is a high sounding title meant to fit the fancy salary we are paying him."

"An' is he to be me boss?" the superintendent inquired suspiciously.

"Not directly, Daniel," the Montreal official replied. "Of course, he will have certain authority over all departments, but Mr. Sylvester is a traffic man. How's everything on the road this morning?"

"An' how should I be knowin', whin the first thing I see whin I open me door is an announcement of an executive somethin' or other?"

McCutcheon's hearty laugh served only to increase the hurt of Marley's wounded feelings.

"No need for you to bother your head about Sylvester," said McCutcheon. "I'll have some conversation with you about him the first time I see you. So long, Daniel."

Keen disappointment shone in Marley's deep-set blue eyes as he pushed the telephone from him. McCutcheon had withheld the information he sought. It would have been kinder had he spoken at once. Better to know the worst than to undergo the agony of suspense.

Gloomily he turned to the business of superintending the affairs of the Ontario division. With a deliberation new to him, he performed each act as if it were his last one. Something told him that when the blow came it would descend with a suddenness that would afford little time for changing decisions.

IT WAS while he was in this dismal frame of mind that the telegram from Barnard Sylvester came, a message courteously worded but clearly mandatory in intent, inviting the superintendent to meet the executive director of transportation in Montreal two days later to accompany him over the Ontario division.

Marley's eyes flashed and his hands became fists.

"Be gar, 'tis a personal job o' liftin' the pin on me official office the mutt be doin'!" he remarked as grimly he set about clearing the accumulation of two years from the pigeonholes of his desk.

When General Manager McCutcheon had confirmed the report of the coming of Sylvester to the A. & P., he had no idea of the storm he was stirring in Superintendent Marley's soul. It would have been all the same in any event. Not that McCutcheon would deliberately hurt Marley. On the contrary, he had the warmest admiration for his superintendent. But, truth to tell, Barnard Sylvester had been forced upon the general manager by Sir Samuel Van Cleve, a new and highly influential member of the board of directors.

Van Cleve was partly right in his belief that the A. & P. needed a man of Sylvester's reputed traffic ability. The inauguration of extra-fare passenger train service a month hence was an epoch-making event in railway circles, and it was no secret that McCutcheon did not favor the addition of a new train in each direction between Montreal and Chicago. Overruled

"Well, Marley," said Sylvester, "it's up to you. If there's a failure tonight it'll be a man failure—one you'll have to answer for"

by the U. & C., his western connection at the International border, McCutcheon had been forced to accede to their demand that new service become effective November first. And in much the same manner was McCutcheon forced to announce the appointment of the man to supply the enthusiasm for the new project, enthusiasm which Van Cleve believed the general manager lacked.

Thus it happened that Daniel Marley, without sufficient cause, had worked himself up to the point of assault and battery, and as he waited for the object of his spleen, that fine October morning, his weather-tanned face was set in grim lines. Prepared to despise the man at sight, Marley found a hard beginning in Sylvester's gripping handshake and the seeming gladness reflected in his dark eyes.

"I've been hearing about you, Marley," Sylvester smiled, and motioned the superintendent to a chair in his private car.

"'Tis nothin' else ye could be doin' if ye ever worked anyplace in the Dominion," Marley naively remarked.

Sylvester laughed and held an open cigar case before his guest.

"WONDERFUL railroad we have," he remarked as the train drew away from Bonaventure Station. "I understand you helped build it."

"That I did, sir." Marley expelled cigar smoke like a volcano. "Wit' me own hands I drive the first spike whin some o' the folks in the west is startled, an' whin it was finished I drive the last one."

"Well, that was quite an honor, being selected to drive the first and last spikes. Who gave it to you?"

"'Twas me own self which had the givin'," he declared. "so I select the man that's handiest with a spike maul, fer the job, which is myself. They call me 'Mile-a-day Marley' in them days, because I lay one mile o' rails ivver day."

"Then you selected the right man." Sylvester smiled approvingly, "and I suppose the track will be good for our new extra-fare train, the Frontier Special?"

"It will that."

"Fine. We have the track, that's the important thing. Then the new equipment and engines should be here in a—"

"Ingines?" questioned Marley. "Is it some ingines we be gettin'?"

"Yes, we are advertising new equipment from engine pilot to observation platform; everything to be lettered "Frontier Special"—even the engine tanks."

"But, Mr. Sylvester, sir, ingines is not built in a couple o' weeks."

"I know." Sylvester smiled knowingly. "I had to do a little second-story work to get them. Incidentally, I had to spend considerable A. & P. Railroad money to induce a railroad and a locomotive builder in the States to part with six engines that had been built for another line. Here's the design," he handed Marley a blueprint, "and here's a picture of the finished product. Aren't they beauties?"

For several minutes the superintendent studied design and photograph. A shadow of annoyance passed over his face as he returned them to the other official.

"An' have ye already boughten thim, an' paid—"

"Contracted for them, yes," Sylvester admitted. "Why? Don't you like the looks of them?"

"The looks is fine," Marley declared, "but 'tis white elephants we'll be a havin' on our hands."

"White elephants!" Sylvester elevated his eyebrows. "Just what do you mean, Mr. Marley?"

"The dimensions of the wheels—too low for high speed. Isn't it a seven-hour schedule ye wish to make wit' the new—"

"Yes, but don't worry about those engines not being able to run," Sylvester smiled. "I rode one of them at fifty-five miles an hour for a short distance not—"

Marley grinned reproachfully.

"Maybe fer a short distance they can, but like a fat man—"

"Pardon me, Mr. Marley," Sylvester interrupted jerkily, "the engines will be here in a couple of weeks. We'll use them on the new trains."

It was a thoughtful Marley that bade good-bye to Mr. Sylvester late that afternoon. The cloud in his sky had already begun taking form. The smiling Mr. Sylvester would personally deliver into his hands the tool with which he must work his own undoing—a tool in the form of a giant locomotive mounted to pull the extra-fare trains.

Ten days later the engines were reported in the yards at Montreal. Calling together his mechanical staff, Marley boarded the first train for the East. Arriving at the outer yards he learned there had been a delay in bringing the engines across the St. Lawrence River. This was due, he was told, to the breadth of the super-locomotives, which necessitated taking measurements in order to determine whether their great pounds-pressure steam chests would clear certain structures. At noon the engines arrived, and the afternoon was spent in firing them up, inspecting and lubricating them for the trial runs.

For a week the tests went on. With a short train of freight cars loaded to the approximate weight of the new passenger trains, Marley and his mechanical assistants thundered up and down the Ontario division. It was a discouraging business, for it forced upon the superintendent a disagreeable duty, one that he felt would only hasten the inevitable call for his resignation. But truth would have no other. Gladly would he have admitted that the design and photograph had deceived him. He knew they had not. Reluctantly he admitted that the engines were impressively designed and capable of hauling heavy tonnage on a mountain grade, but he was prepared to prove by actual tests that they were not built for high speed.

WHEN Marley told McCutcheon the engines could not make the time with the extra-fare trains, the general manager uttered a half-suppressed chuckle and sent for Sylvester. The executive director of transportation came, cordiality in his eyes and warmth in the enthusiastic handclasp he gave Marley.

"Well, how are the new engines testing out?" he asked.

"Sure, Mr. Sylvester, sir," Marley hesitated, "'tis me that hates to tell ye, but thim engines reminds me more an' more o' some sacred oxes which I onct see in the zoo."

Sylvester threw back his head and laughed heartily.

"So you've changed them from white elephants to sacred oxen, have you, Marley?"

"I have, an' sorry I be to say the wurrds. We must use our

old ingines on the new trains," he announced firmly.

"No, we can't do that, Marley," Sylvester frowned. "We've advertised the new engines and we'll use them. If your men are afraid to run them, I'll have the factory send —"

"Divil a bit is me min afraid!" Marley cried. "But, Mr. Sylvester, sir the ingines, they can't make the time."

"Yes, they can make the time, and they must."

SYLVESTER turned to the general manager.

"If that's all you wish to see me about, I'll be going. I'm due at the Algonquin Golf Course right now."

Sylvester smiled his way out. Marley sat staring at McCutcheon. The general manager saw the mute appeal in Marley's gaze and he drummed on the table with his fingers.

"You've heard the saying, Daniel—'power behind the throne'— haven't you?" He forced a smile.

"But I be tellin' ye, Mr. McCutcheon, thim ingines —"

"I know, I know," McCutcheon interrupted testily. "but Sylvester is handling that. I've agreed to let him do it. I've agreed to a number of things recently that I don't particularly favor but— "

"Be gar, if I was general manager," Marley started to protest, but the look in the other man's face stopped him.

"Take my advice, Daniel, ' McCutcheon said in a tired voice, "don't antagonize Sylvester Go the limit for him—as you have always done for me "

It was a perplexed Marley that started toward the elevator. Just what had McCutcheon meant by "power behind the throne '? And "go the limit" for a man that . . . Could it be that McCutcheon ?

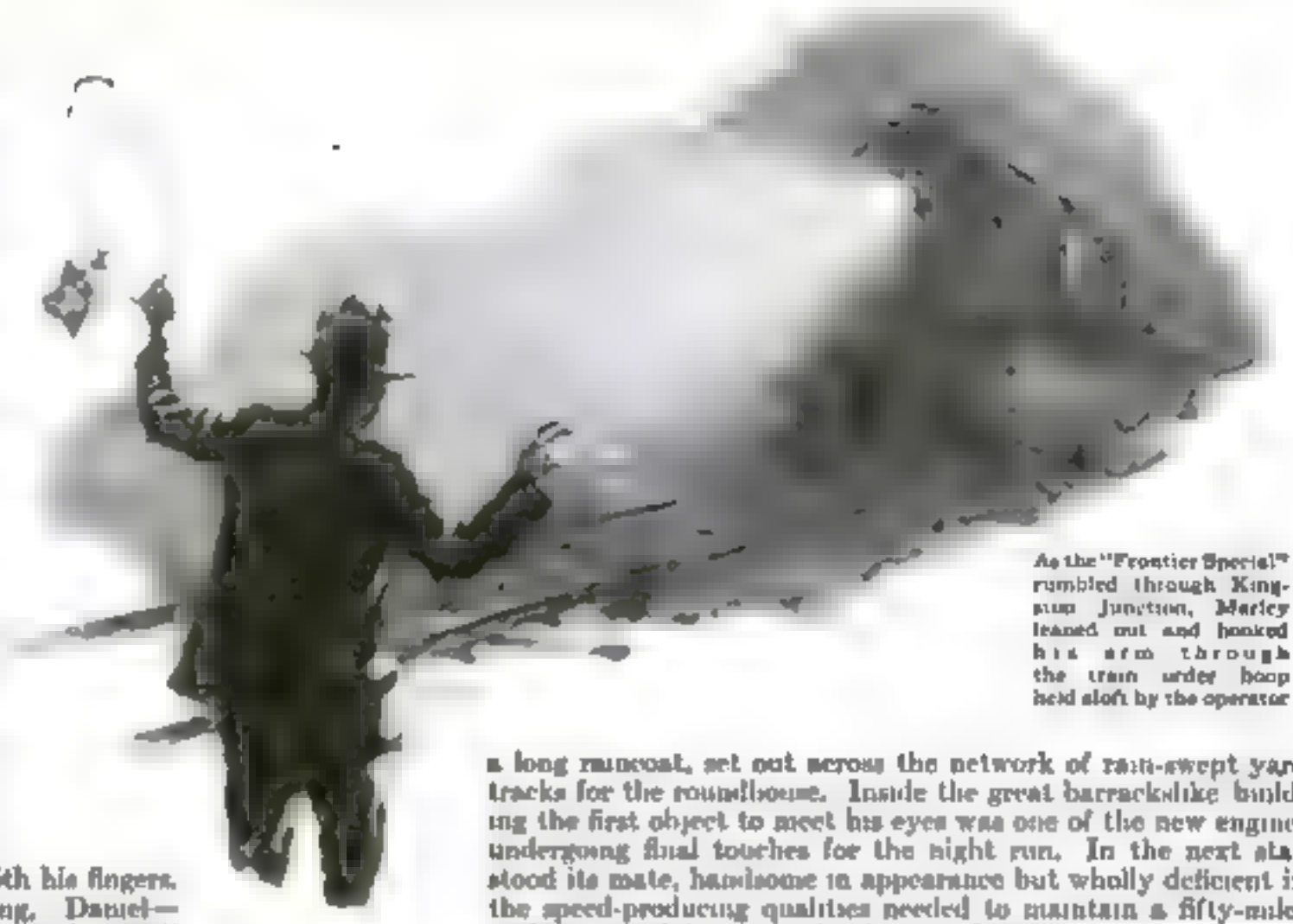
November first dawned cold and rainy In his private car in the outer yards in Montreal, Marley woke to a day which promised only dire disaster. If Sylvester were only out of the way, he reflected, what a day it could be! Then he could use his splendid high-wheeled engines on the new trains; engines that already had more than a year's flawless service behind them, instead of Sylvester's expensive misfits.

The temptation to defy Sylvester had been in his mind for a week. He had only played with the idea. Marley knew he could not afford to run counter to the will of his superior officer—without the general manager's approval. And McCutcheon's significant warning that he go the limit for the other man had crossed his mind countless times since that last interview Well, he knew that the path of wisdom led away from anything designed to confound the new official. And what was infinitely worse, he knew that that path led to certain failure, for tonight the new train service was to be inaugurated.

NOW, failure of any kind was a thing apart from the stuff that generated Marley's life. To fail with the eyes of the railroad world upon him, to go limping into Toronto hours late with a fine new train, a train whose only excuse for existence was the guarantee of "on time" service in return for the extra fare charged, this was a bitter thought. And what rendered the situation almost unbearable was the knowledge that the failure which hung like a terrible specter before his eyes need not occur. For the A. & P. Railroad had capable engines idling in its roundhouses, engines specially built for high speed, any one of which could easily make a whip-cracker out of the "Frontier Special."

"If Mr. McCutcheon only Fave me tell him that Sylvester's greener than a goose about railroadin'," he muttered, a hard light in his eyes.

In spite of his worries, Marley breakfasted well, and donning



As the "Frontier Special" rumbled through Kingston Junction, Marley leaned out and hooked his arm through the train order hoop held aloft by the operator

a long raincoat, set out across the network of rain-swept yard tracks for the roundhouse. Inside the great barracklike building the first object to meet his eyes was one of the new engines undergoing final touches for the night run. In the next stall stood its mate, handsome in appearance but wholly deficient in the speed-producing qualities needed to maintain a fifty-mile-an-hour schedule across the Ontario division.

With a grunt of disgust Marley passed on to another part of the shop where painters were at work on the tender of an engine that was the pride of his heart—the great 931. His eyes lighted as they fondly rested upon drivewheels as high as his own head and upon the towering symmetrical boiler to which was coupled a long cylindrical tender.

"Be gar, if I could use the 931 on the "Frontier Special" this night," he muttered, "'twould be— "

He stopped short and stood staring at the engine. Then, in a moment his jaws snapped and, swinging about, he hurried to the master mechanic's office.

An hour later Marley's private car, drawn by engine 931, slipped out of the yards, headed for the west And at about the same hour, a full sister of the 931 was speeding eastward from Toronto, each in obedience to Marley's command, bound whither only the train dispatcher at Kingston Junction knew.

THE waiting rooms and ramps at the Bonaventure Station in Montreal were jammed with an eager crowd long before nine o clock, the hour set for the westward departure of the A. & P.'s extra-fare train. On track Number 11 the train stood, colorful and splendid in brilliantly lighted equipment and newly uniformed crews, the finest product of car-building art.

Railway officials jostled newspaper and picture men and happy passengers followed grinning porters struggling with new luggage through the crowds.

McCutcheon and a group of passenger department men stood near the observation car, to which car was hung a large round marker bearing in rose-colored lights: "Frontier Special"

At the front of the train Marley paced and, with a look of disgust on his face, watched Sylvester posing for the picture men. One hand resting on the shoulder of the engineer and the other touching the great steam chest of the locomotive, the executive director of transportation smiled into the camera while a flashlight was made. Then, observing Marley, he beckoned the superintendent to his side.

"Well, Marley," said Sylvester, losing his smile for a moment, "it's up to you. As I've told you, we have the track, the engines —everything. If there's a failure tonight, it'll be a man failure, one that you'll have to answer for."

Marley's face flushed and his lips moved to reply, but no words came. A blind rage possessed him, a fury that sent hot blood surging through him. He wanted to throttle the man, to choke and throw him aside as he had subdued drunken mule skinners back in his track-building days. Something within held him, and wordlessly he turned to seek out McCutcheon.

The train was about ready to start when the general manager felt a hand tugging his sleeve.

"Oh, hello, Daniel," he smiled dryly. "Everything lined up for on-time performance tonight?"

(Continued on page 130)

Our Sun Is Shrinking!

Reduces 800 Miles in Three Years; Strange Flickerings Upset the Weather and Radio

By ARTHUR A. STUART

Reading instruments at the solar observatory on Mt. Brukkaros, Southwest Africa. One of the thermometers shown records a minimum of 0 degrees. The Observer reading a thermometer housed in ground at right is on Table Mountain station, California

YOUR radio set picks up a distant station you never heard before. The barometer outside your window jumps to "Fair"; another 800 miles away sudden ... indicates "Rain." A swarm of mosquitoes buzzes about your screens. These would seem to be a set of unrelated coincidences. Yet all have sprung from the same cause—the sun has slacked up momentarily on its job of supplying the earth with heat and light.

Startling new discoveries that link up the sun's brilliance, sun-spots, the weather, and radio have just been announced by Dr. C. G. Abbot, of the Smithsonian Institution at Washington, D. C. They are the achievement of the men who have watched the sun daily from the observation stations that the Smithsonian Institution maintains at scattered points on the globe—at Table Mountain, California, in the desert at Calama, Chile, and on desolate Mt. Brukkaros in Southwest Africa.

W. H. Hoover, director of the Smithsonian Institution's Mt. Brukkaros station, making measurements of the sun's radiation. Notice the observers hut at left

WHEN the sun "flickers" from day to day, they have just discovered, so does weather change and radio misbehave. Sunspots, too—the mysterious magnetic whirlpools on the sun's face—appear and disappear with these flickerings. And the biggest solar commotions occur every twenty-two months, well within the eleven-year "sunspot cycle" already known. This means that in a little less than two years today's weather is likely to repeat itself.

Long-distance weather forecasting soon may follow. Already Dr. Dayton C. Miller, noted astronomer and physicist who invented the machine that compared weather and sun records to help make these discoveries, has used the machine to make startlingly accurate solar predictions. The Chile observatory reports his predictions fulfilled. H. H. Clayton, weather forecaster for the Argentine Government, has been using the Smithsonian reports of the sun's flickering to prepare weather predictions a week in advance. Sold to Argentine farmers and business men, they have proved strikingly accurate.

Fast as we are learning how the sun behaves, the "why" of it is still a mystery. Where does the sun's unending heat come from? What caused the sunspots blamed for the torrential rains that recently flooded Berlin and started a mosquito plague? Or the others that deranged this country's telegraph lines last April?

Down where the sun's heat comes from, in its incandescent interior, is some dense substance twelve times as heavy as the radioactive metal, uranium—that has the heaviest atoms known on earth. Einstein ... new ... of ... atoms as Dr. J. H. Jeans, English ... new ..., and ... a mixture of familiar ... under such terrific heat and pressure that their molecules ... and ... Hydrogen ... water. The latter is the belief of Dr. ...

Huge atoms, says Dr. Jeans, are continually breaking down, like radium, and loosing the energy that the sun hurls to us. Could these be "coronium," a new element found on the sun by eclipse observers? Dr. Abbot says the opposite may be true. Perhaps, he suggests, small atoms are ... and ... some of their ... electric energy. This might explain the discovery by Prof. Giuseppe Armellini, Italian astronomer, that the sun has shrunk more than eight hundred miles in diameter since 1924. It waxes and wanes in size, and every time it gets smaller sunspots increase.

At present the sun is having an unusually severe epidemic of sunspots, presaging strange weather and freak electric storms. The sun's corona, always more striking at a time of many sunspots, was unusually intense during the eclipse last June. At Giggleswick, England a wind blew away heavy clouds three minutes before the total eclipse, and permitted the party of Sir Frank Dyson, astronomer royal, to make observations of inestimable value, using a forty-five-foot camera to photograph the vivid corona.

Could Air Invaders Destroy Us?

Ruin of Great Cities by 4000-Plane Armada Made Possible by Progress of Ocean Flight

By CALEB JOHNSON

THREE airplanes have just flown across the Atlantic. Another has crossed the Pacific from San Francisco to Honolulu. By the time this appears in print another half dozen transoceanic flights may have been made. Which raises the question:

If four, why not four thousand?

The flight to Hawaii was a military demonstration. It proved that military airplanes can cross 2400 miles of water and find their destination by the unaided use of their own instruments, even when their mark is so small a speck on the earth's surface as the Hawaiian Islands.

It is apparent from these latest flying feats that something has happened since the President's aircraft board was asked eighteen months ago to solve this puzzle: "Is the United States in danger by air attack from any potential enemy of menacing strength?"

"Our answer to this question is no," said the board, after examining ninety-nine experts; but it qualified the "no."

"This conclusion is based on the facts *as they now are*," said the board. "No airplane capable of making a transoceanic flight to our country with a useful military load, and of returning to safety, is now in existence."

THAT last statement is still true. Why worry? What has happened?

Just this. These recent feats have proved that aviation is not standing still. They have brought forcibly home the fact that in the nine years since the war ended flying has progressed further than in the dozen years before, when men were just learning to fly. At the same rate, the "facts as they now are" will be as obsolete nine years from now as the facts when the war ended are obsolete today.

The highly developed monoplane and the radial engine are the outstanding advances since the war—those and the earth inductor compass. But these are by no means the last word in aviation. It is a practical certainty that the next nine years will see the development of planes and engines "capable of making a transoceanic flight to our country with a useful military load."

It is easy to say that nobody will want to invade us. It is also foolish.

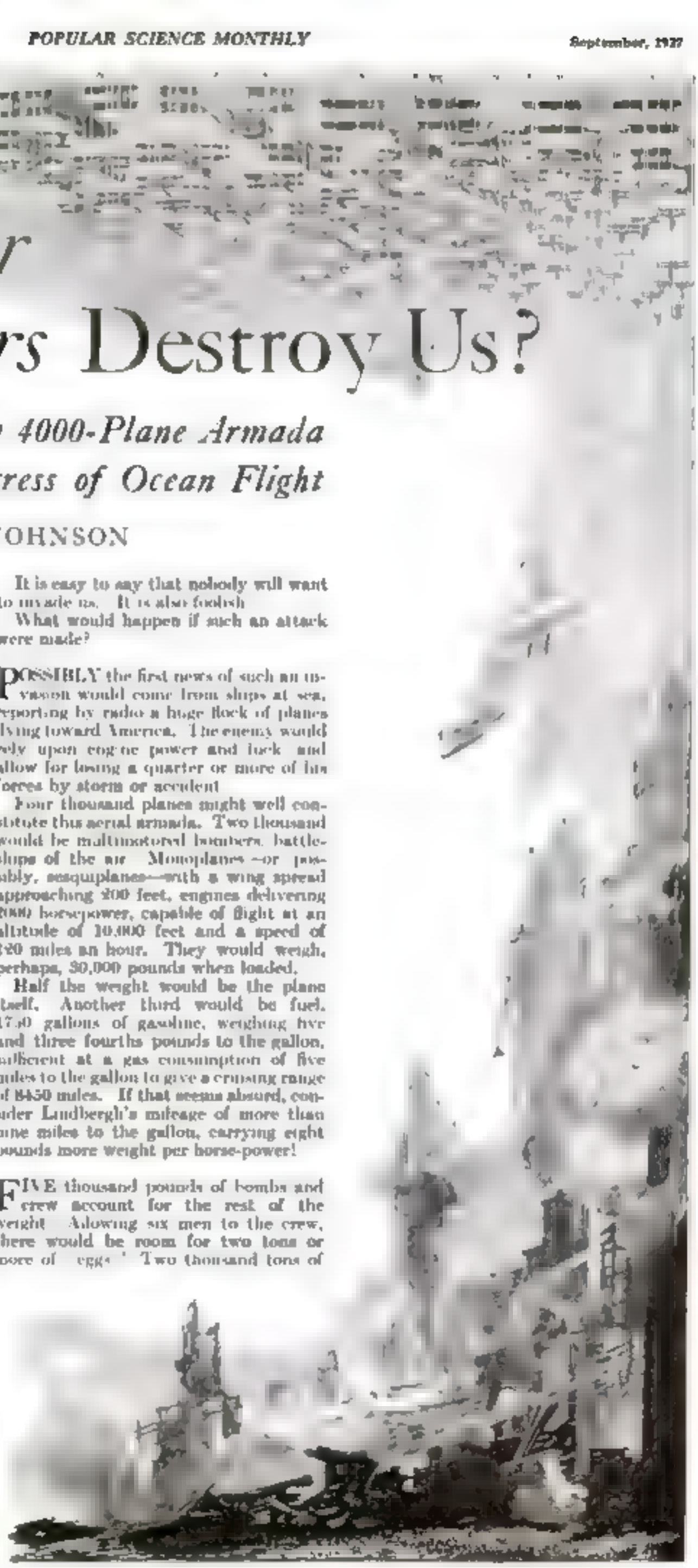
What would happen if such an attack were made?

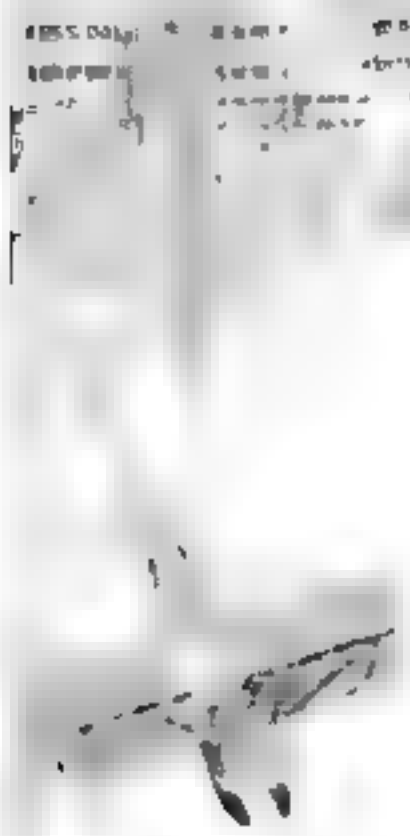
POSSIBLY the first news of such an invasion would come from ships at sea, reporting by radio a huge flock of planes flying toward America. The enemy would rely upon engine power and luck, and allow for losing a quarter or more of his forces by storm or accident.

Four thousand planes might well constitute this aerial armada. Two thousand would be multimotored bombers, battleships of the air. Monoplanes—or possibly, sesquiplanes—with a wing spread approaching 200 feet, engines delivering 2000 horsepower, capable of flight at an altitude of 10,000 feet and a speed of 120 miles an hour. They would weigh, perhaps, 30,000 pounds when loaded.

Half the weight would be the plane itself. Another third would be fuel, 1750 gallons of gasoline, weighing five and three fourths pounds to the gallon, sufficient at a gas consumption of five miles to the gallon to give a cruising range of 8450 miles. If that seems absurd, consider Lindbergh's mileage of more than nine miles to the gallon, carrying eight pounds more weight per horse-power!

FIVE thousand pounds of bombs and crew account for the rest of the weight. Allowing six men to the crew, there would be room for two tons or more of eggs. Two thousand tons of





The drawing on these pages is our artist's conception of the annihilation of a great city such as New York or Chicago by an armada of airplanes, blackening the sky with their numbers, topping buildings with a rain of thousands of explosive bombs and killing the populace in hundreds of thousands with a deluge of deadly gas

high explosive bombs would be more than enough to destroy the essential nerve-centers of our nation. The enemy could lose three fourths of his battle fleet on the way and still have munitions left to paralyze the heart of America.

Flying in triangular formation, like a huge flock of geese, this bombing fleet would cover more than a hundred square miles of sky. Ahead of the bombers would be the scout cruisers of the air, a thousand two-seater observation planes. Each would carry 300 bombs, charged with poison gas far deadlier than anything yet used in war. And above the observation planes would be the third unit, the high-speed pursuit planes, swift single-seaters ready to go into action the instant our aerial defenders should appear on the scene.

An attack by airplanes would be all the enemy would really fear. While artillery and naval experts believe anti-aircraft guns have been or soon will be made effective weapons, experienced air fighters ridicule the idea that "archies" can ever be a serious menace. Not more than a dozen hits were made against such huge targets as Zeppelins by the British anti-aircraft guns, in all of the 107 Zeppelin raids over Great Britain during the last war. And many of these hits did not bring down the airships.

Draw a triangle on the map of the United States, with its angles at Boston, Minneapolis and Atlanta, and you have included in its area most of the nation's wealth, industries, important railroad centers, seaports, electric power sources and population. At this heart of America the enemy would strike with high explosive bombs and poison gas to destroy railroad terminals, industrial plants, water supplies, electric power systems, shipping and docks, telegraph and telephone centers and financial institutions.

The enemy would divide his fleet into squadrons, to make practically simultaneous attacks upon widely separated points. Destruction of Chicago's rail terminals would practically cut off transportation between east and northwest. The great steel works of South Chicago and Gary might be wrecked. One plane could cut off Chicago's water supply by blowing up two pumping stations.

Similar tactics would be employed at the other Great Lakes cities, Detroit, Cleveland and Buffalo. At Detroit the automobile plants would be destroyed.

NEW YORK would be the focus of the enemy's most intensive efforts, and chaos would prevail should the enemy succeed. To cut off New York completely by rail it would be necessary only to wreck the ferry terminals, destroy the Pennsylvania tunnel and demolish the three bridges which give rail communication northward. The wreck of Hell Gate Bridge would form an effectual blockade to Long Island Sound navigation. Less than a ton of gas dropped at each end of the Pennsylvania tunnel would prevent its use for weeks.

Explosive bombs could destroy the largest ships in New York harbor and shatter power houses, throwing the city into darkness and tying up transit lines. Tall buildings in the downtown section might be shattered to paralyze the financial machinery of the nation.

Sixteen tons of gas, according to experts, can destroy all life in an area of a square mile. Doubtless there will be improvements in gas as well as in airplanes before such a series of events as we are discussing here could take place.

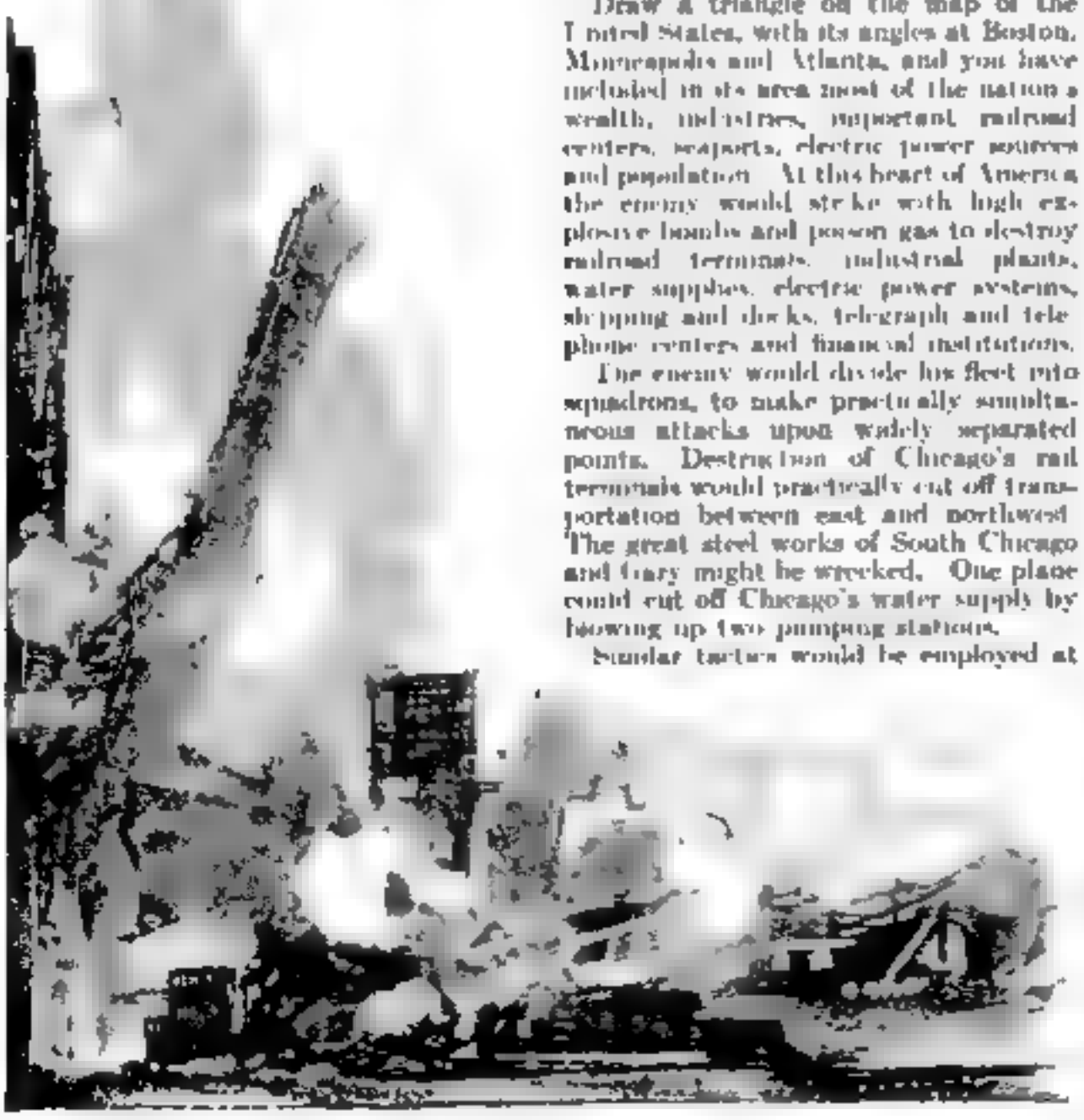
Tens of thousands might perish in the panic of the first gas alarm should the attack come during business hours. It takes nearly two hours to empty the skyscrapers of lower New York of their workers. Statisticians have calculated that if all of the persons employed south of Fulton Street should leave the buildings at once they would fill the streets of downtown Manhattan three deep! The struggle to leave all at once would crush thousands to death in stairways and elevators.

New York is never provisioned for more than ten days; the outlying districts are seldom more than that ahead of starvation. With the main food supplies destroyed or inaccessible, famine would quickly prevail.

A horrible picture? Yes, but a possible one. Not probable, but possible.

It goes without saying that no nation today is able to attack the United States by air. On the whole, the military and naval air power of the United States equals that of most other great powers and is superior to that of many. But there are differences of opinion. The President's aircraft board reported that the figures of our Army's airplane strength ranged all the way from 34 planes to 1396! Somewhere in between is the truth about our effective fighting air force.

And if some nation should resolve to bring America to its knees, some time in the future, with airplanes developed as far beyond those of today as those of today are ahead of 1918, what has been pictured could happen, and possibly would happen unless our country were prepared for war in the air.



How Animals Make Love

Zoölogists Watch Insects Woo by Gifts, Perfumes and Mad Dances—Queer Courtships of Birds and Crocodiles

By ELWELL CRISSEY

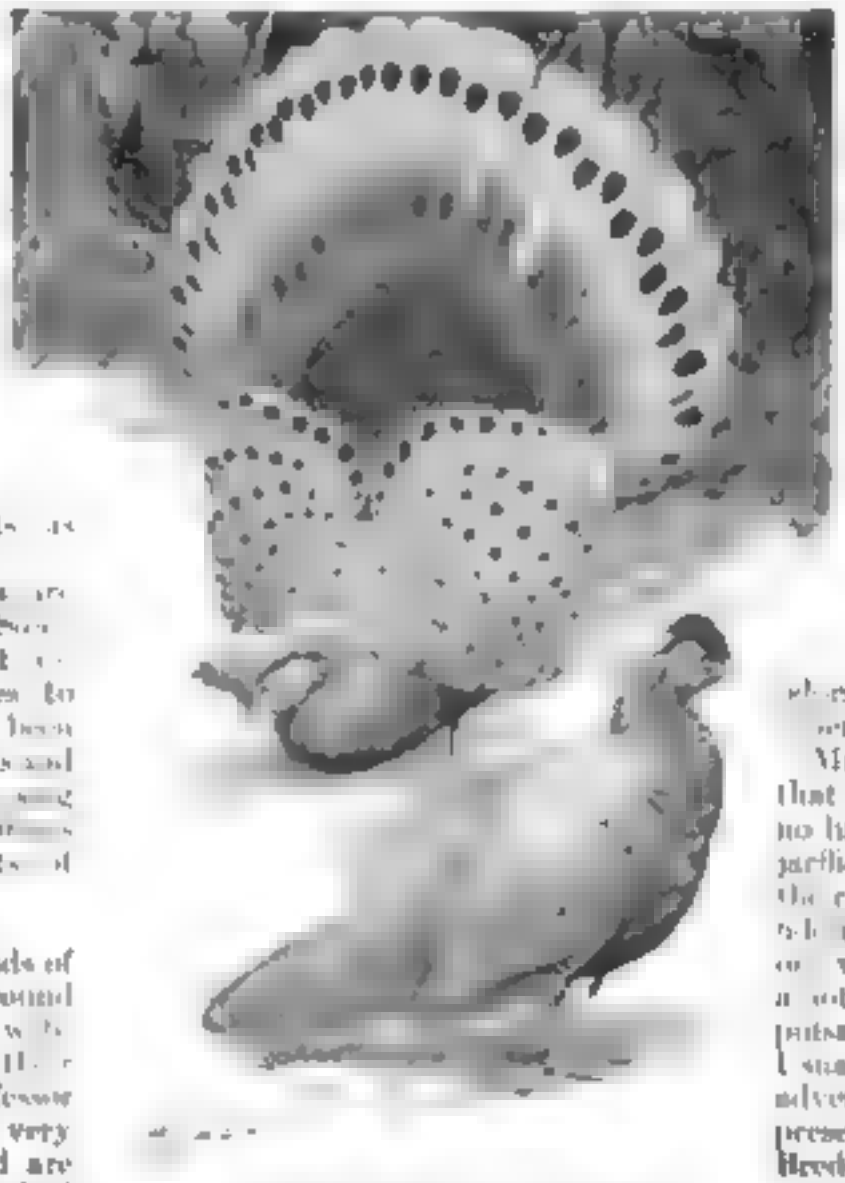
WHEN a young man gives his best girl a bouquet or a box of candy to show his affection is he making love as only mankind knows how, or is a similar courtship practiced by the animals, birds and insects?

Professor Julian Sorell Huxley of Oxford University, started a vigorous debate among naturalists recently when he told the British Association for the Advancement of Science that he had seen lowly forms of animal life dance, sing, pose and give presents as part of complicated love affairs.

In many ways these courtships are astoundingly like human conduct. Some insects Professor Huxley told about use delicate flower and fruit perfumes to make themselves appealing. It has been known for some time that many birds and animals, and even some reptiles, sing love songs to their mates. And dancing is a favorite way among the insects of showing deep affection.

FOR example, observe the two kinds of spiders, the hunters that prowl around and capture their prey, and the web spinners that wait in ambush for their victims. These two varieties, Professor Huxley says, do their love-making very differently because the latter kind are almost blind. He described how he had watched the male hunters go through a series of complicated dances in front of their sweethearts. On approaching his mate one lover was seen to humph himself up on one side and crouch down on the other by doubling up his legs. In this ridiculous posture he sailed rapidly around in front of Miss Spider, and then suddenly reversed and went the other way. He circled nearer and nearer. At last, apparently won by the demonstration, she rushed toward him. The swain held her off by his forelegs, slowly retreated, and started circling all over again. More than 100 circles were counted before the two joined for a last mad whirl, round and round in one spot. Some of these waltzing spiders are decorated with bright spots of color.

BECAUSE the web-spinners are practically blind, they have to express their love by other ways than dancing. Professor Huxley contrasted their subtle methods with the wild display of the hunters. The web-spinner comes up to the web of his ladylove, much as any modern Romeo might come to the balcony of his Juliet. Instead of strumming a ukulele, though, he strokes a thread of the net, setting up peculiar vibrations which the lady spider recognizes as different from the agitation a fly causes when entangled in the net. This cautious announcement is quite necessary, too, otherwise the vicious lady might mistake her lover for a stranger and eat him! Among some varieties she does this anyway, after mating.



A typical courtship in wild bird life. The male peacock pheasant spreads his gorgeous plumage to attract his modestly attired lady love; apparently she pays little attention. Among nearly all species of bird and animal life the males display decorative coloring, while the females are drab and inconspicuous

One kind of hunting spider entices his mate by offering her a choice fly neatly wrapped in silk. This same instinct of giving presents, which figures so largely in human courtship, appears also in the carnivorous flies, *empidæ*. The male of this species makes a flower bouquet for his love. First he blows up a ball of bubbles from a viscous fluid which he secretes, then he attaches it to his legs, and sticks a flower petal or a little leaf in it. Describing this peculiarity, Professor Huxley stated, "Here, in quite a different evolutionary line from our own, we find quite definitely the employment of a nonutilitarian present as gift from male to female." Some of her varieties of this fly make their gifts useful, though, by tucking a morsel of food instead of a flower into the balloon.

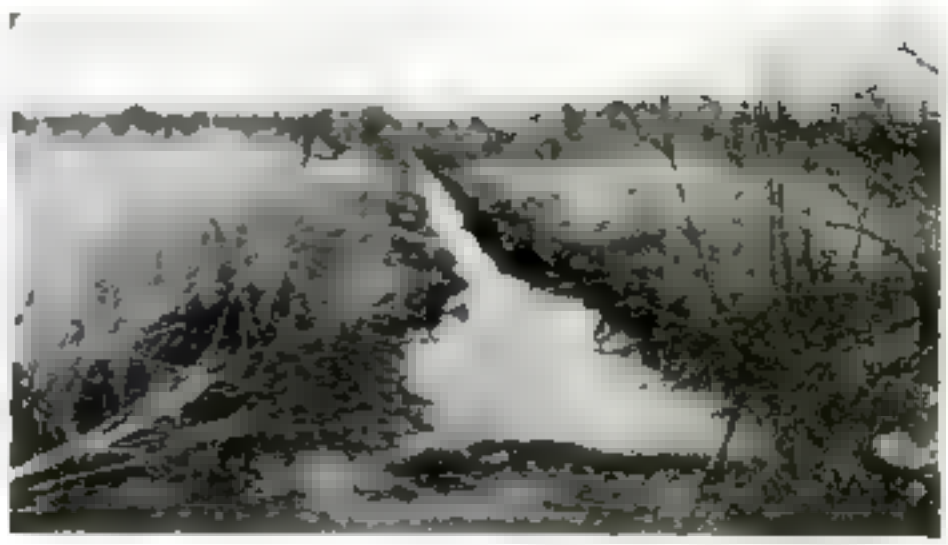
BUTTERFLIES and moths shame all other creatures in the gorgeousness of their colors, and yet, strange to say, they do not use color to make themselves attractive to their own kind, but employ perfumery. The white powder on the wings of the male garden white butterfly smells delicately of balsam or lemon. Some butterflies have even rose perfume, and the magnificent Brazilian varieties carry still heavier odors. This appeal to smell is used by their lovers, too, as we shall see presently.

Man is by no means the only creature that woos by serenades. The insects have no lungs, of course, so cannot sing. But katydids, crickets, and grasshoppers send their love calls far and wide by loudly rubbing their wings over their legs. Anyone who has lived in the country during a hot summer has heard the monotonous, pulsating song of the frogs and toads. Usually these noises are merely vocal advertisements, which broadcast the presence of the males, but Dr. C. M. Breder, Jr., of the New York City Aquarium, tells of one frog courtship, which was won entirely by the bullfrog's fine bass voice.

A BIG frog was bellowing on the edge of a pond, he says, when a female approached and paused in interest. The bullfrog stopped singing and almost immediately saw Miss Frog start hopping off towards other serenaders near by. The jilted one appeared disappointed, and started after her, but seeing that she paid him no more attention, returned to his bower and started singing louder than ever. The fickle one stopped, listened, and seemingly made mental comparisons, then hopped back to her first choice.

"Crocodile tears" long has been a synonym for make-believe sympathy—laughed at because it seemed impossible to conceive of crocodiles showing any delicate emotions. And yet we are now told by naturalists that the homely crocodile shows a greater ecstasy in his love-making than possibly any other creature! When showing off before the idol of his heart, young Mr. Crocodile puffs himself up almost to the bursting point, then raises his head and tail high in the air and twirls himself around in the shallow water, churning (Continued on page 144)

Digging a drainage ditch with dynamite. Tons of earth are flung high, instantly completing a job that otherwise would require several weeks



A ditch dug by dynamite at Tyler, Tex., to drain low marshland in a campaign to destroy mosquitoes and fight malaria and other diseases

Blasts *That* Saved *a* City

Wonderful New Uses for Dynamite, the Giant That Tames Floods, Digs Tunnels, Topples Cliffs and Catches Whales

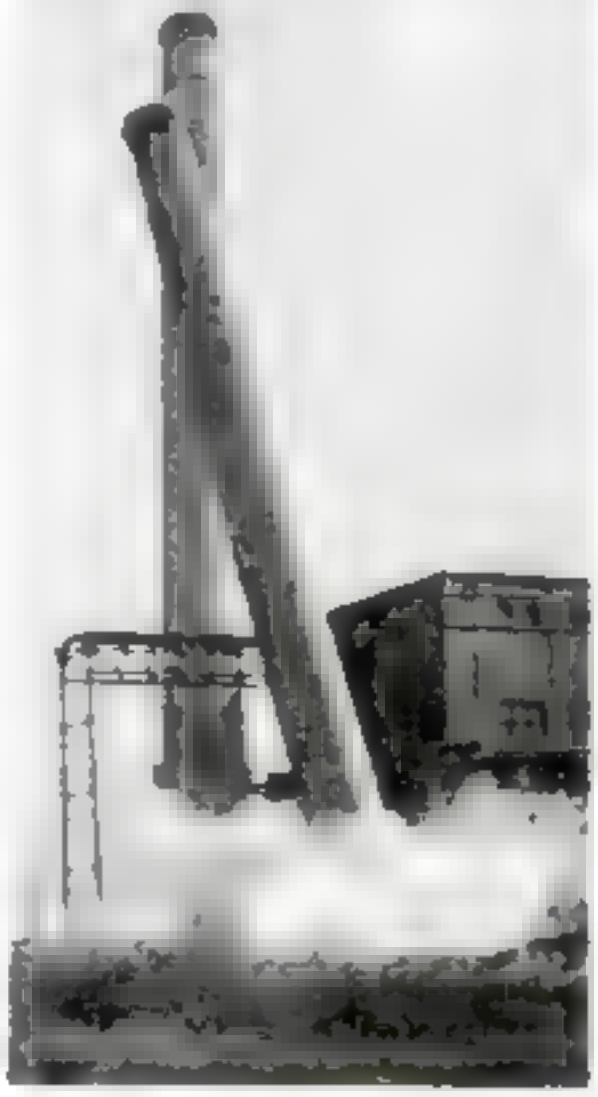
By
ORVILLE H. KNEEN

WEEKS of heavy and widespread rains over forty-one per cent of the country's area had swelled the Mississippi to a deluge. Half a million people had lost their homes, crops and businesses. As the crest approached the great port of New Orleans, La., all records were topped, until the waves lapped over the levees. Behind 100 miles of dikes another half million citizens trembled at the thought of a crevasse which might inundate 90,000 square miles of basin, lying ten to twenty feet below the levees. To John Ehret, levee engineer, they gave "plenary powers to do all things necessary and requisite" for the city's safety. He decided to relieve the pressure of flood waters by opening the main levee at Poydras, a few miles below the city.

WITH seaplanes circling and patrol boats and guardsmen clearing a three-mile zone, a diver placed three quarters of a ton of dynamite in forty-eight holes in the levee, and fired. A trickle of muddy water seeped through. Other shots were placed. Swiftly the current eroded the crevasse, until it roared through a 3,000-foot opening, sweeping across fertile lands to Breton Sound. Above the break the river stayed level, then lowered two and a half feet. At a cost of $5,000, thirty-five tons of dynamite saved the city. The millions to be paid the owners of inundated lands will be only a fraction of the loss that would have been suffered had the torrents made their own opening. Hundreds of lives and millions of dollars were saved by the only force which could break the mighty dams.

To learn more about the uses of this wonderful agent of force, I went recently to the men who produce it.

"Modern high explosives," said Col. George G. King, President of the Institute of Makers of Explosives, "can force a way through any obstacle Nature has erected. American industry is using explosives in ways undreamed of a few years ago. Blasting powder and dynamite are used to mine coal. The metals in your telephone, iron, copper, lead, and others, all are blown from the ground. The buildings, tools and machines of our daily lives depend upon explosives to get iron ore for steel, rock from which cement is made, lead for paints. Even ice cream is cheaper because dynamite blasts out rock salt used in its freezing. Without explosives, industries as we know them would come instantly to an end."



A perfectly planned dynamite blast at an electric power plant in Baltimore, Md., brings down a towering smokestack without doing the least damage to costly buildings near by

So powerful are these modern genii compressed in the little orange-colored cartridges, I learned, that they have even brought oceans together. Fifty million pounds of dynamite, laid in holes which, together, end to end, would have reached three times through the earth, opened a passage through Culebra Cut in the Panama Canal.

THE explosive nitroglycerin was discovered in 1846. In 1863 Alfred Nobel made liquid nitroglycerin into safe dynamite, by adding an inert substance, kieselguhr. For sixty-four years dynamite has moved the earth and the waters thereof, that man might build skyscrapers and dams, canals and channels, ports, highways, railroads, subways—even kill mosquitoes and whales! The story of dynamite has no counterpart in the realm of chemistry, engineering, or romance.

In the last twenty years Samuel R. Russell, senior technical expert for the du Pont company, has shot more than 6,000,000 pounds of dynamite—probably more than any other man in the world. He has never failed on a job. He told me how dynamite recently tamed the Arkansas River at Pueblo, Colorado.

"Cloudbursts and rapid melting of mountain snows caused the river to leap its banks. It flooded the city fourteen feet deep in places, and enormous jams of rocks, logs, mud and debris began to pile up the water over miles of lowlands. Scores were drowned and more than $10,000,000 damage had been done when men hurled sticks of dynamite, with wires attached, into the midst of the jams and so saved further loss.

"Pueblo wanted no more such floods. With the aid of dynamite again, a new

Sculptors dynamiting rough outlines of the heads of Jefferson Davis and Stonewall Jackson for the Confederate memorial on the face of Stone Mountain, Ga.

channel for the river was cut straight through the city, 250 feet wide and deep enough to carry off twice the maximum flood waters. More than a million cubic yards of rock and earth were blasted out, much of it within a few feet of dwellings, without injury or damage. A barrier dam was erected six miles above the city. The irresistible force of water was curbed by the even greater force of dynamite!"

Every spring northern rivers hurl enormous blocks of ice against piers, bridges, boats and power houses. But wherever the jam is the worst has become the place for a gelatin-dynamite party. This shattering explosive is waterproof, and will sink. Once when an ice jam in the great Niagara Falls gorge was blasted, about 9700 pounds of dynamite was fired in two charges. That was an extreme case, the ice being seventy feet high. One bad winter, I was told, the fishing village of Stonington, Maine, located on an island, was saved from starvation when dynamiters mounted a huge ice jam and cut a channel for relief boats.

EXPLOSIVES will tear apart iron, steel or masonry as readily as will cold chisel and hammer, pick, sledge or crowbar—and more effectively. A cast-iron pulley wheel, weighing more than a ton, once was blasted into pieces and the hub removed without harming the shaft to which it had rusted fast.

One manufacturing concern not long ago found itself with a surplus brick chimney 150 feet high, almost encircled with valuable buildings ten to fifty feet away, and a new $9 000 stack only nine feet distant. They gave C. V. Weaver, an expert, the job of reducing the stack to brick and mortar within a narrow lane leaving intact several thousand windows, and many delicate silk machines. He arrived with a box of dynamite, a blasting box, a brick drill and a tamping stick.

The expert sighted a center line along the narrow "landing field," and marked where it intersected the stack. Then he drilled a series of holes halfway around the stack, fifteen inches above the ground, partly through. In the rear he drilled another row of "weakening holes" clear through three feet from the ground. When sticks of dynamite, placed in the holes, were fired, the result was like chopping down a giant tree. The stack tottered, then swayed and fell with a roar. The job required an hour and five minutes, and the only thing broken was the silence.

The same expert once dropped a tall stack so accurately that it drove a long up stake into the ground. Again he lifted a cornerstone from a building without injuring the records contained within, and reduced a huge safe to bits without the bank's patrons knowing what was going on. When asked for his "secret" he remarked: "It's all a matter of being careful. Handle dynamite correctly, and it will do almost anything you want it to do."

Above: Machine used to fire 1 000 explosions in six minutes during filming of war scenes for a recent motion picture. Each mine and shell was exploded by a wire leading from a contact on the semicircular control board

Right: One of the levee blasts that saved New Orleans. Workmen are seen in the picture laying new charges within a stone's throw of the blast

Russell explained to me how dynamite does its work.

"An explosive exerts an expansive force, which works along the lines of least resistance. The charge must be proportioned to the depth of the hole and the mass around it. The charge can be so placed that all its force will be absorbed by the material, either shattering it into fragments or merely cracking it.

"IT MAY surprise you to know that the tearing force of TNT is only equal to that of medium strength dynamite. Its advantage, however, is that it can be handled, dropped, even melted or fired into without detonating. An entire car was burned last year without exploding. TNT is used for shells, bombs and mines, but is too costly for ordinary use. Black powder, made of saltpeter, sulphur and charcoal, is used for blasting coal, slate and marble, also for fireworks and fuses. Smokeless powder, the most difficult of all explosives to make, is now the best explosive for ammunition.

Tons of dynamite have been employed to tear down miles of vertical rock cliff, as was done recently for an approach to the Bear Mountain bridge over the Hudson River. In large cities, when blasting is to be done, mats of woven cable are placed over the charge. Recently I heard a New York dynamiter reprimanded because a few pebbles cracked a window across the street! Yet he had lifted from a hillside dozens of 100- and 150 ton masses of solid rock as large as a garage, and had laid them on the ground within fifty feet of apartments.

Dynamite has opened the earth for the passage of railway trains, automobiles, water and power supplies. It made possible the new vehicular tube, under the Hudson River, through which 17,000,000 motor cars will drive every year. In northern California the Pacific Electric has blasted a tunnel twenty-three feet high by twenty-two wide to lead an underground river four miles to its turbines. In Colorado the Moffat Tunnel through the Continental Divide, now virtually completed, will save twenty-three miles of railway travel and 2,466 feet of climb. In the Argentine the tunnel between Amadores and Alpian cuts the running time from twenty-seven to eight hours. When the (Continued on page 123)

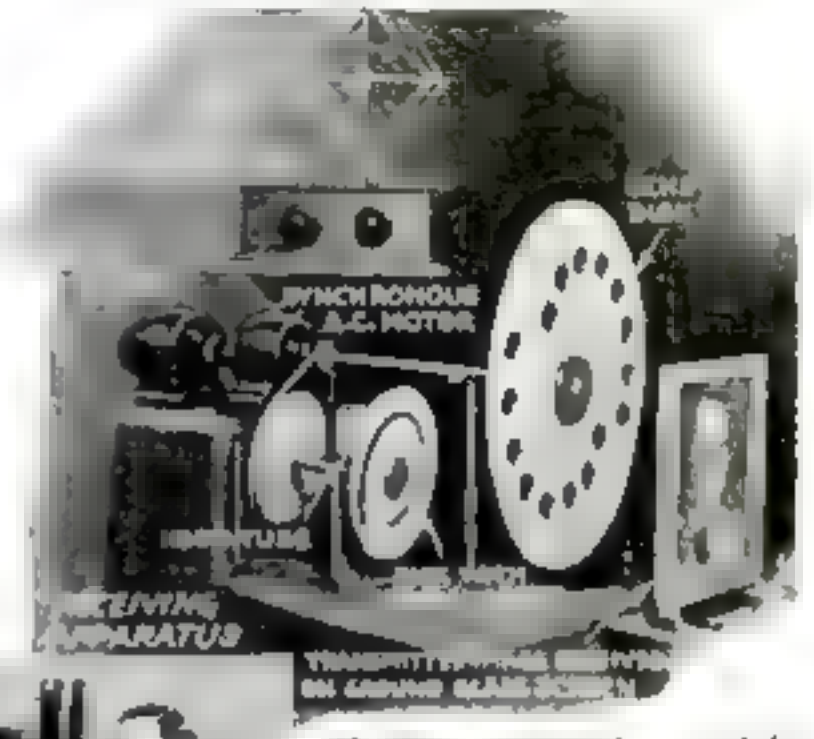
Next We'll *See* to Paris

So Says John Baird, Who Brings His New Television System to America to Prove He Can Do It

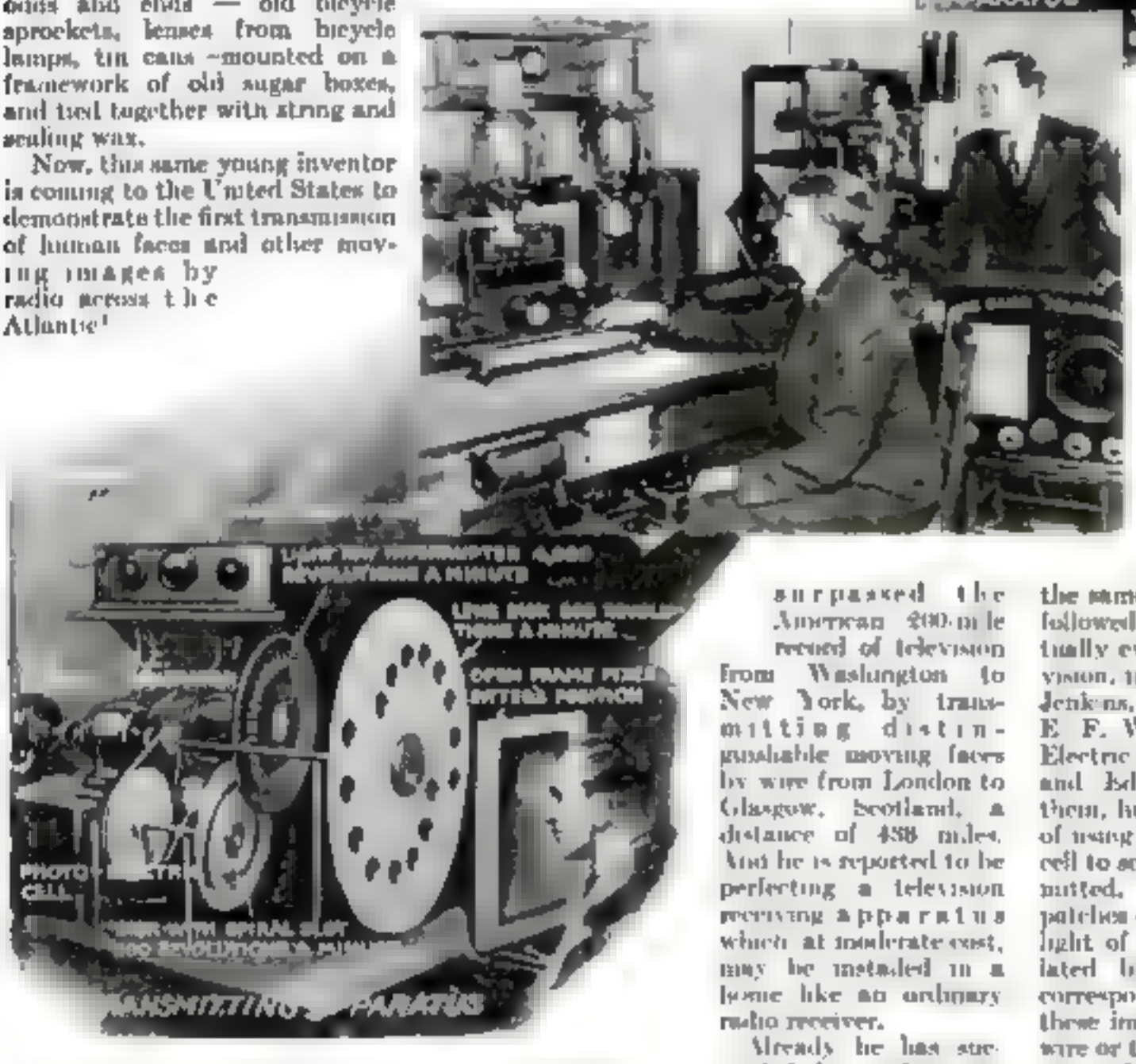
By GEORGE LEE DOWD, JR.

LESS than five years ago John L. Baird, a young Scotch inventor, labored in an attic room in the Soho district of London, with few possessions save the dream of achieving electrical vision at a distance. His experimental apparatus he had made with his own hands from derelict odds and ends — old bicycle sprockets, lenses from bicycle lamps, tin cans —mounted on a framework of old sugar boxes, and tied together with string and sealing wax.

Now, this same young inventor is coming to the United States to demonstrate the first transmission of human faces and other moving images by radio across the Atlantic!



Right The Baird radio vision receiving apparatus. Light from a neon tube controlled by incoming signals, passes through lenses in a rotating disk, reproducing the transmitted image on a ground glass screen. Below The inventor of the apparatus J. L. Baird, in his workshop in London



In the transmitter rotating disks divide the face into patches of light of varying intensity These the photo-electric cell translates into correspondingly fluctuating electric current

While engineers of the Bell Telephone Laboratories have been astonishing America with the first practical demonstrations of distant vision by wire and radio, as described recently in POPULAR SCIENCE MONTHLY, Baird, in England, has been achieving similar wonders. He has established what has been called the world's first television transmitting station Station 2TV licensed by the British Post Office. A few weeks ago he surpassed the American 200-mile record of television from Washington to New York, by transmitting distinguishable moving faces by wire from London to Glasgow, Scotland, a distance of 438 miles. And he is reported to be perfecting a television receiving apparatus which at moderate cost, may be installed in a home like an ordinary radio receiver.

Already he has succeeded in sending the "sound of a face" some three thousand miles across the Atlantic. Recently as he sat before his "televisor" in London scratchy sounds produced by signals carrying the image of his face were recorded in New York.

A year ago so poor that an attic bedroom-laboratory was his only available stage for a demonstration before members of the Royal Institution in London he comes to this country with the backing of a $125,000 company which, it is reported, plans to establish a number of television stations here and in Europe.

Baird is one of the remarkable figures in invention today. For, working virtually single handed, he has solved an enormous problem which elsewhere has required the elaborate apparatus of great research laboratories and the co-operation of hundreds of expert minds. And in basic principle the television system which he has worked out is strikingly like that which required the services of nearly a thousand men in the recent Washington-New York demonstration.

In fact, he has made use of the same general theory which has been followed, with varying success, by virtually every recent experimenter in television, including such men as C. Francis Jenkins, of Washington, D. C., Dr E. F. W. Alexanderson of the General Electric Company research laboratories, and Edouard Belin of France. Like them, he has developed his own method of using the light sensitive photo-electric cell to scan the face or scene to be transmitted. The face is divided into tiny patches of varying light and shade. The light of each of these, in turn, is translated by the photo-electric cell into corresponding electric impulses, and these impulses in succession are sent by wire or through the ether. At the receiving end they are translated back into light and patched together into a mosaic likeness of the original.

The problem of television always has been to speed up this process to the point where to human eyes, it will give a truthful effect of motion. This requires the scanning and transmission of an entire face or scene at least sixteen times a second —the speed of motion pictures.

In this, Baird has gained success first, by the invention of an extremely sensitive photo-electric cell, the exact nature of which he has kept a guarded secret; second, by an

(Continued on page 155)

Why We Mob Heroes

A Noted Psychologist Explains Our Frenzied Idolatry of Aviators, Athletes, Movie Stars · Even Murderers!

By A. A. BRILL, M. D.

Doctor Brill is one of the world's foremost students of human thoughts and emotions. A physician and psychologist, he brings his knowledge here to explain recent popular waves of hero worship. He has been head of the psychiatric clinic at Columbia University, and lecturer on abnormal psychology at New York University, and is the author of widely read works

WHY has Charles Lindbergh stirred two continents to the wildest frenzy of hero worship ever accorded a single human being?

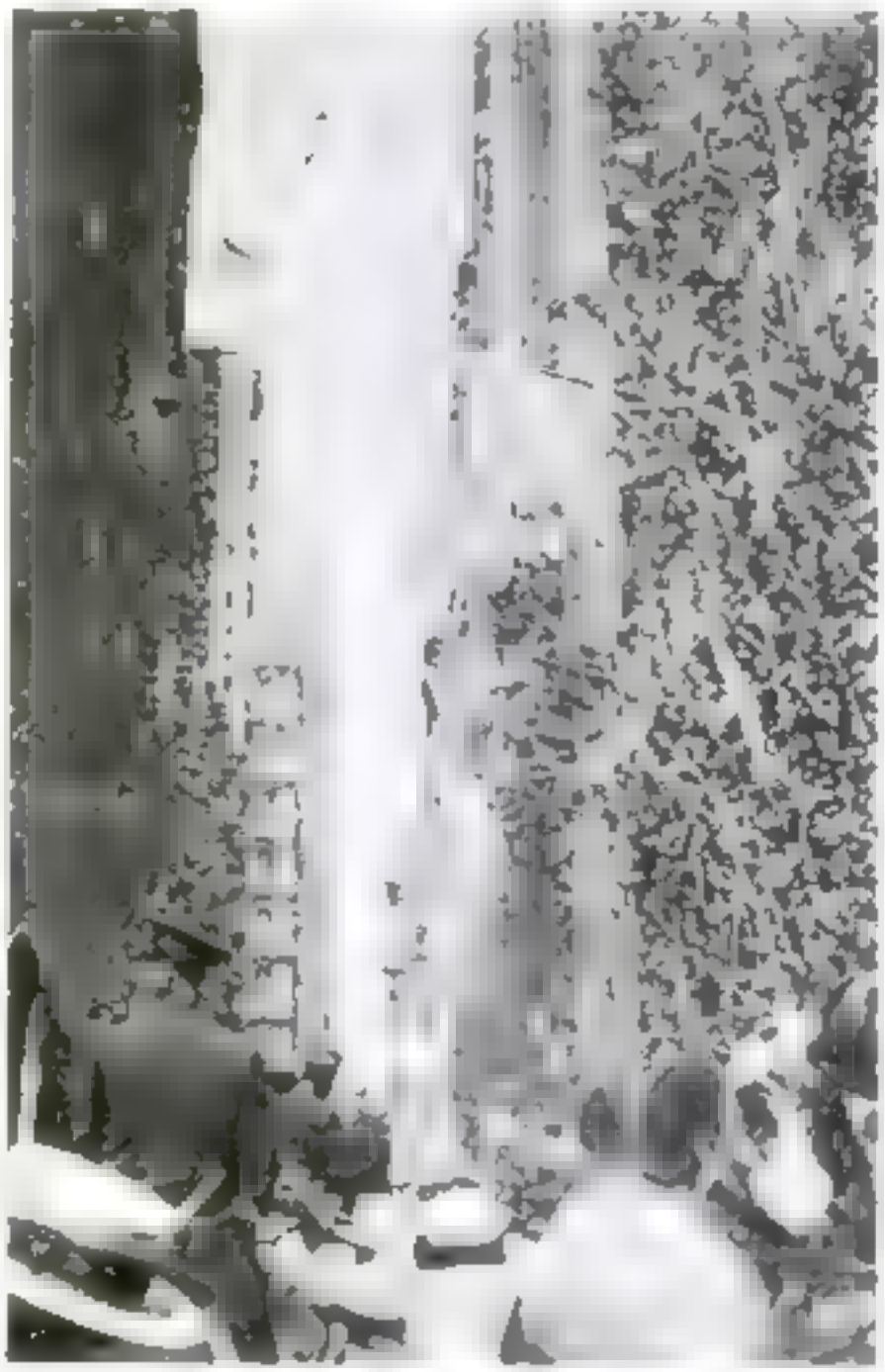
Why do we mob motion picture stars, go mad over the first woman Channel swimmer and idolize baseball celebrities and boxing champions? Why, for that matter, did thousands cluster on the street corners of New York just to watch the passing of a condemned murderess on her way to Sing Sing?

The international outburst over Lindbergh differed from many recent explosions of hero worship only in its intensity. "Red" Grange, Helen Wills, Gertrude Ederle, Bobby Jones, Byrd and Chamberlin—they and others have in turn swept us off our feet in a storm of crowd hysteria.

What is back of this odd phenomenon?

Why does hero worship erupt tumultuously at the death of Valentino, while the simultaneous passing of a great educator like Charles W. Eliot attracts only meager notice?

Among the mere onlookers at Lindbergh's triumphant parades were veterans of the war and pioneers in aviation who had risked their lives as daringly as he, and for greater causes. Orville Wright, who made the airplane possible, was a secondary figure in the news photographs of Lindbergh, who used the airplane in a thrilling but practically useless feat.



The wildest display of hero worship ever accorded a single human being—New York City's hysterical welcome to Charles Lindbergh. The photograph shows lower Broadway as Lindbergh passed in a downpour of ticker tape and confetti. In idolizing Lindbergh, says Dr. Brill, millions found an outlet for repressed instincts

I have asked some who joined in the Lindbergh frenzy to explain their own emotions. The best answer they have to offer is

"Oh, I don't know. I just seemed to have the Lindbergh bug."

Those who noted at Valentino's funeral, and those who fought their way into the courtrooms to catch a glimpse of Ruth Snyder or "Peaches" Browning on the witness stand, are equally unable to describe their true motives.

Yet the fundamental explanation is really the same in each case. Whether we are cheering Lindbergh or gossiping about "Peaches" Browning, it is the cave man speaking out within us.

In these popular obsessions with some personality of the hour, man's primitive self is bursting through the restraints of modern civilization. The violent energies of sex and of belligerency—the great appetites for pleasure, power and immortality—thus find outlet.

I have a friend who has had to stop going to boxing matches because he always gets into trouble. As the fight waxes furious in the ring, he begins lashing out blindly with his own fists—and some of his neighbors acquire bloody noses.

The stimulus of the roaring crowd around him and the sight of the boxers' blows release pent-up primitive impulses. But most of us are able to transform such emotions into cheering and catcalls. We are all, for the moment, such unbalanced hero worshipers that we call upon our favorite to kill his opponent, and the group hysteria around us gives social approval to our demands for gore.

In other words, "the bug" that bites a frenzied hero worshiper is the germ of crowd contagion. But the man battened is not his civilized self. It is the savage ancestor within him. Remember that in tens of thousands of years, man's physical structure has not perceptibly altered, but in a few thousand years his mode of living has changed materially. Instead of a jungle cave he now has a cozy fireside, police to protect him, a corner grocery store to furnish food. But he has the same nerves, the same glands, the same muscles and internal organs as the cave man; and he still has the same reserves of energy seeking outlet through them.

TODAY we can't go around fighting our neighbors, stealing their women and slaughtering animals. But the unchanged savage within us wants to. We find an outlet for these primitive instincts by going to the movies, the football games, the murder trials and prize fights.

By identifying ourselves with the actors in these public spectacles we secure an emotional outlet for our own repressed energies. This release, obtained in shouting or pounding a neighbor on the back, is called an emotional catharsis. I go to boxing matches not only to get it myself, but to study its effect on others. I paid $55 to see a four-minute fight between Dempsey and Firpo, and I got my money's worth because every second of it was violent action. But I saw Wills

and Firpo go twelve rounds and everybody shouted, "Fake!" Because there was no action or blood, the cave man within them had not been released emotionally.

WHEN the football player or varsity oarsman puts forth "superhuman" efforts in the last gruelling moment we see evidence of these latent powers. The intense emotion aroused in a close contest sets free the athlete's primitive reserve of energy. That is why "Red" Grange can run faster in a game than he could if nobody were chasing him, it is why Helen Wills played "superhuman" tennis against Lili d'Alvarez.

They say in Washington that President Coolidge made the most telling speech of his career in his welcome to Lindbergh. The emotions stirred by a nation's hero worship called forth in him unlapped powers of oratory.

But how does all this explain hero worship itself?

Let's take various types of cases. Jack Dempsey for one. Why does the small boy worship Dempsey and ignore Gene Tunney who licked him?

Dempsey in build, in physiognomy and in methods of fighting typifies brute force. Tunney is thought of as the gentleman, the highbrow. He frankly fought to make money. Jack Dempsey fought, so the small boy thinks, because he loves to fight. One of the small boy's chief desires is to shine in physical combat.

Because Dempsey typifies the born fighter, his followers seize upon him as the supreme embodiment of the unsatisfied fighting instinct within themselves. Furthermore, Dempsey in defeat has been trying to come back. We are all of us defeated by life at every turn. We are beaten in business. We are beaten in golf. We, too, want to come back.

There you have the answer. Every object of hero worship represents some simple or complex wish unsatisfied in our own lives. The popular idol can do things which we cannot, but which we want to. By projecting ourselves into his rôle, and by celebrating his exploits, we enjoy a release of emotions more intense than the ordinary routine of our lives permits.

As a youngster I used to go down to a saloon on Essex Street, New York, just to look at a picture there of John L. Sullivan, the greatest pugilist of them all. John L. fought all the time. Crowds would gather just to stare at his gloves exhibited in a window. Anything closely associated with a hero helps the onlooker to make more vivid his self-identification with the hero's deeds.

Remember that our emotions are feelings which accompany the completion of a current through our nervous system. Some object stimulates the outer nerves of touch or sight, the stimulus, perhaps comparable to an electric current, passes to the infinitely elaborate telephone exchange of spinal cord and brain, and from there it is sent out again to selected muscles and glands through whose operation we feel the emotion.

THAT'S why the crowd stared at John L. Sullivan's gloves, and why the Parisian mob tore pieces from Lindbergh's plane. If a small boy can make off with a ball knocked over the fence by Babe Ruth, he shares among the rest of the gang some of Babe Ruth's glory. Thus things associated with a popular hero seem to have supernatural powers, and the hero himself becomes a sort of demi-god.

Children still get satisfaction in fairy story heroes. But adults, experienced with the reality of life, have to find their release in another kind of fairy story. They find it on the stage, on the screen and in modern fiction. On the screen you see people just like yourself, in surroundings like your own, gratifying desires which you cannot gratify. You project yourself into them, live through the adventures they are having, and so escape from the realities of your own existence.

Now the popular film stars, whether Mary Pickford, Charlie Chaplin, Douglas Fairbanks, or who you will, are always the same in whatever part they play. Thus it is not the character played by a star, but the star himself who becomes a sort of demi-god, able to realize freedom from the hard facts of the average man's life.

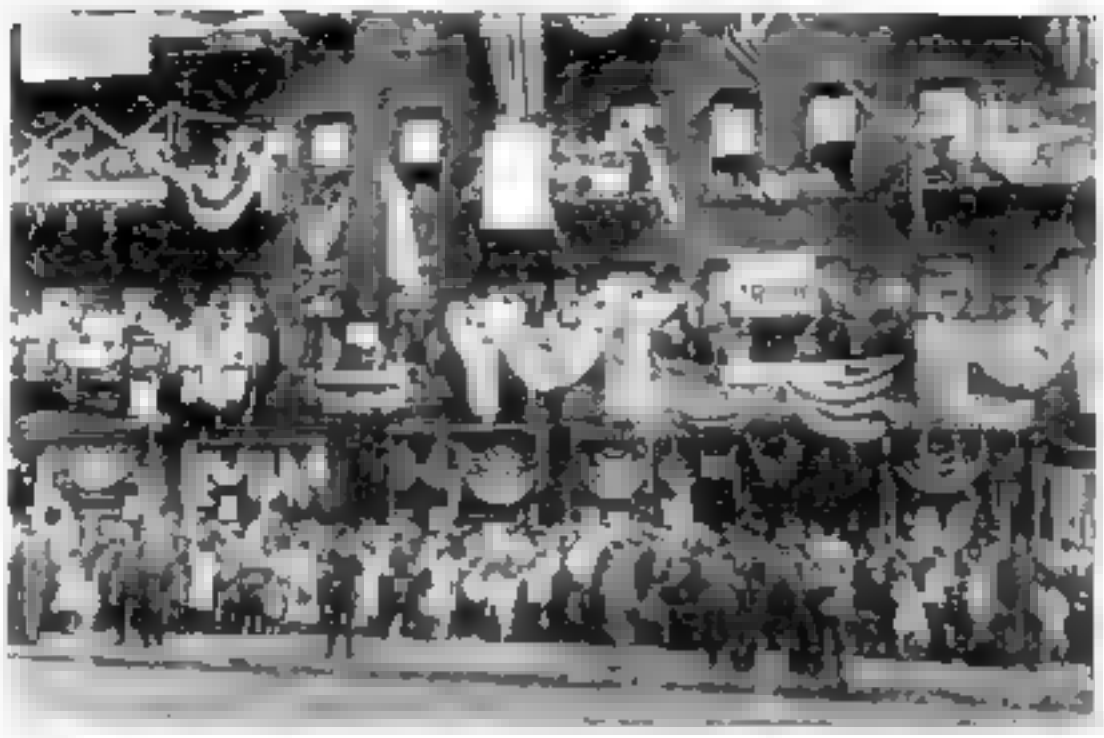
For instance, a girl once showed me a letter she had received from a famous motion picture star. She was fluttering with emotion as she held it in her hand. A divinity had raised her to his level by deigning to write to her. When I said that I had heard her hero started as waiter in New York, she was utterly crushed.

Hero worship requires that its object be something above and apart from us ordinary mortals. If the hero is not superior, how can he achieve the desires denied to us?

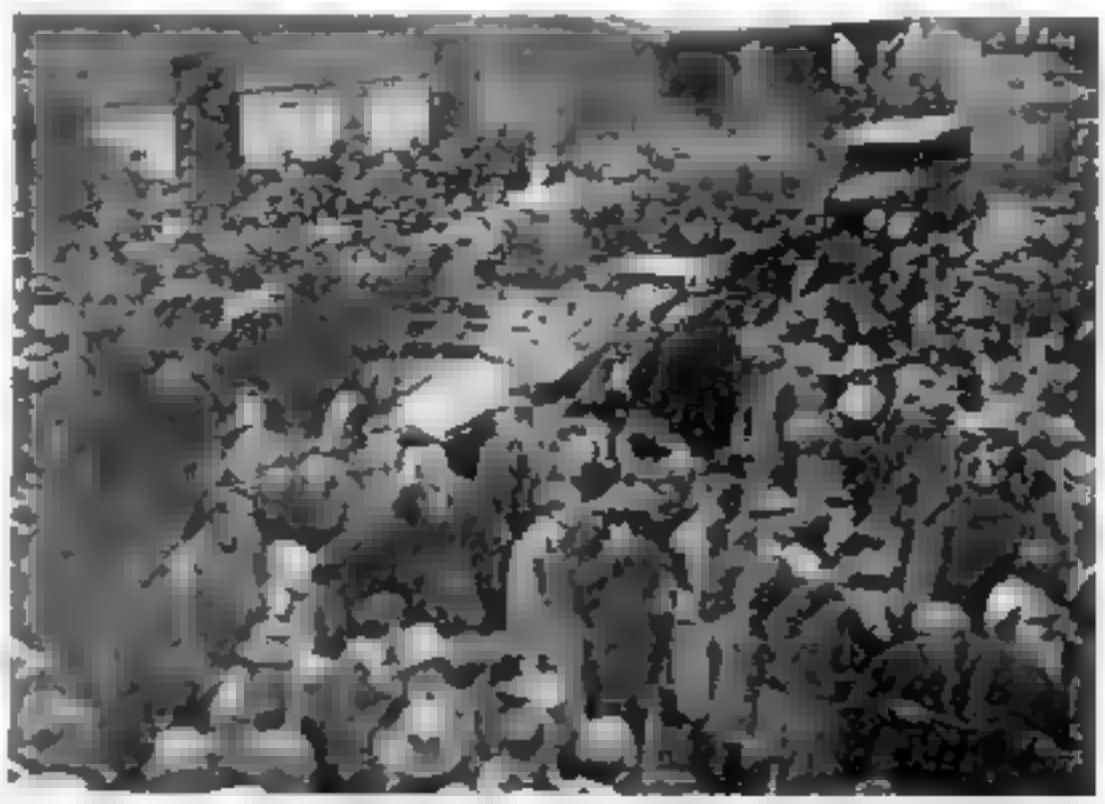
Sooner or later every hero is discovered to be only a human being. Then he falls from grace.

Valentino would have fallen, but he died in time. There is no mystery about the demonstrations surrounding Valentino's death and funeral. The death of no other star would have aroused similar intensity of emotion, because no other star typified so perfectly the Great Lover for this age. The women who sat in Valentino's audiences were, in imagination, replacing the actress who received his kisses.

CONTRAST this with the case of Douglas Fairbanks. Fairbanks is the fairy story type of hero. He does impossible things, performs athletic feats which we envy, and he carries off the girl only incidentally. But Valentino was the love-maker in concentrated form. Through him millions obtained a by-path outlet for the strongest and most re-



Millions went mad over Gertrude Ederle the first woman to swim the English Channel. She personified their balked desires for physical conquest over the elements, and they enjoyed emotional release in celebrating her exploit. This view on Amsterdam Avenue, New York, shows the elaborate welcome prepared by her neighbors



Crowds welcoming the Prince of Wales on his arrival at Aberystwyth, Wales. Students are seen dragging his car by a rope to the University College. The young prince symbolizes the fulfillment of man's inner craving for social distinction

It required a force of strong-armed London "bobbies" to save Mary Pickford from the crowds which almost mobbed her. Like other great movie stars, she has commanded the worship of multitudes, who rejoice in her a sense of freedom from hard, unromantic facts of daily existence

pressed of their primitive instincts.

Hence, while he lived, he was mobbed wherever he went. Women sought to get near him, to touch him, to pass notes to him, just as the youngster tags Jack Dempsey around or tries to make off with one of Babe Ruth's home-run baseballs. And when Valentino died, women jammed the funeral church. Those who attend a funeral are intimately associated with the deceased. Women striving for emotional intimacy with their hero, through participation in his funeral, created a jam that called for police control.

THE simultaneous passing of a great educator produced no similar mobs of mourners simply because the desire to be a great educator is not deeply rooted in us. Our cave-man desires are to excel in love, war and the chase—not in learning. It is action we crave.

Your small son wants to be a policeman, a fireman, a sailor or airman or soldier. He wants to be the husky grown-up who *does* things.

Modern civilization encourages us in mental accomplishment. But it thwarts our physical reserves of energy. So it is the frustrated physical instincts that attach themselves to popular heroes.

Now, to take another type of hero worship before we come to the extreme case of Lindbergh, let's consider Ruth Snyder. In cases like her sensational trial our elemental wishes again account for the mobs that squeeze into the court room. Most of us are able to repress the desire to transgress the law and moral conventions. But the law and conventions are recent compared to the primitive instincts we have inherited from remote past.

SINCE the desires are still shut up somewhere inside of us, we are eager to see them enacted in real life by others. The woman who murders her husband so she may share the insurance money with her sweetheart interests us because she has broken laws which, in some way or another, we all chafe against. The interest in Ruth Snyder was only another form of hero worship. That part of our primitive selves which chafes against social restraint was actually glorifying her, although with our spoken thoughts we united in condemning her actions.

In every case of hero worship, then, the fundamental explanation is the identification of ourselves with another who succeeds in doing something we want to do, either consciously or unconsciously. Sometimes our want is one of the elemental instincts, backed up by an untapped reserve of physical energy. Sometimes it is a higher ambition, which I call the wish of human beings to annihilate space, time and mortality.

We don't all want to swim the English Channel, any more than we want to murder members of our family. But we do want to be superior to our fellows. That is one of the ambitions that makes for human progress. The girl who swims the English Channel, and the man who flies alone to Paris, personify superiority and freedom from the hard, earth-bound realities of our own lives.

So they are objects of widespread interest. Publicity concentrates upon them. The social stimulus of publicity intensifies still more our own interest. We break out into various forms of applause. The applause gives us a pleasurable outlet in action, for the pent-up energies which modern civilization ordinarily compels us to restrain.

At an inter-collegiate football game, for example, insane yelling becomes a social convention. Others do it, and so you can. You may be a phlegmatic person, at various points in your nervous system there are centers of resistance that stand in the way between stimulus and muscular response. But at some point the stimulus from the crowd's action is strong enough to break through these resistance points, and you, too, begin to yell.

The resistance once broken is not as strong next time. The emotional outlet through a certain channel becomes a habit. That is why some of us are baseball fans, some fight fans, or golf or tennis fans.

MASS outbursts of welcome to homecoming heroes may become a habit in similar fashion. Lindbergh's reception would have been likely to exceed previous demonstrations because we had learned the trick and enjoyed it. But the Lindbergh craze was an extreme case in the annals of hero worship for several interesting and human reasons.

To begin with, he received more publicity than any other individual in history. In the first two weeks following his start from the Pacific coast to New York he filed 27,000 columns of newspaper space. His mother was deluged with 250,000 more clippings concerning him than the press bureaus made concerning Peary after the discovery of the North Pole. Through newspapers, magazines, radio, movies, wirelessed pictures, the eyes of two continents were focussed upon him.

But why was all this publicity given?

His flight was part of a contest. We are always interested in contests. We stop to watch when we see two dogs fighting. Life being a struggle, only those who are interested in contests can survive. Every form of adult play is a contest, whether bridge or golf, shooting or fishing.

And these contests are comparatively useless, just as Lindbergh's flight, Ederle's swim and Byrd's polar hop were practically useless to the rest of the world. The player who (continued on page 142)

Premier Mussolini of Italy reviewing an army of wildly cheering Fascisti. The hysterical worship of his followers, says Dr. Brill, is the outburst of primitive instincts for leadership and power

Above: A mechanical loader, operated by tractor, dishing up half a ton of sugar beets. A windlass at the back hoists the bucket, after it has been driven into the beet pile. Then it backs on its own track and drops the load into a truck Below: A tractor hauling a trainload of crops

Plows 1000 Acres a Day

World's biggest wheat man demonstrates how machinery helps solve farm problems

By
WHEELER McMILLEN

IF A farmer of the time of the Pharaohs had come to life in America in 1927 he could have gone to farming with about the same tools he left behind him in ancient Egypt, it was remarked recently by the world's biggest wheat farmer, Thomas D Campbell But he would be submerged in wonder were he to show up today on Campbell's huge farm where more than half a million bushels of wheat are grown each year entirely by machinery!

With the equipment on his great wheat farm, Tom Campbell can plow 1000 acres a day and harvest 2000 acres a day. In a single day he has plowed, disked, seeded, and packed a full section—640 acres. One of his huge engines will at one time perform all those operations on a strip twelve feet wide, sowing thirty acres a day

For eight years Campbell has grown an average of 40,000 acres of wheat annually, and since 1921 has done it profitably. Each year, as his industrial methods are improved, his costs go down. Fifty tractors, ranging from forty to seventy-five horsepower, drive his machinery. Mechanics' wages are paid to the workmen. The big power units reduce the costs until Campbell's wheat is probably the most cheaply produced in the world.

In its size, and to an extent in its equipment, Campbell's immense farm is unique; yet it is typical of the transformation which mechanical science has worked in the American farm.

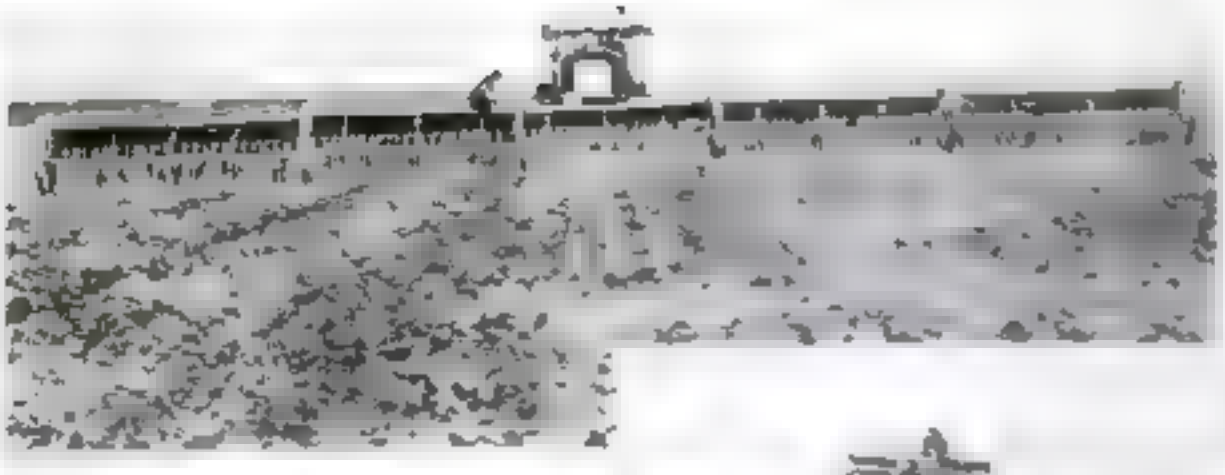
After the Civil War, the blue-clad veteran laid aside his musket to grasp a plow handle, a hoe, a sickle, a pitchfork, a cradle, a corn knife, and a husking peg. From his easy chair today, the old veteran listens to throbbing tractors, pulling wide bottomed gang plows, swift two-row cultivators, combines, and corn pickers.

The pioneer broke his wheat ground with a two-horse plow, cutting a ten or twelve-inch furrow, and smoothed it with a two-horse harrow. Swinging a heavy bag under his arm, he broadcast the seed a handful at a time. He cut the wheat with sickle or cradle, tied the sheaves with straw, and threshed the crop by hand with a flail, later with a horse-power threshing machine.

Contrast those rude methods with the system of harvesting employed on Campbell's great farm. There four binders are hitched behind one tractor. The sheaf-tying device is removed, and extension carriers provided, so that the four binders deliver the cut grain loose in one continuous windrow One man suffices for the four machines. The grain cures quickly. The combine then goes down the windrows, threshing as it goes, dumping the grain in wagons and leaving the straw on the ground. Three men operate this machine; a dozen and a half are required for the ordinary threshing machine. The expense for twine and for hand-shocking has been eliminated, and Campbell's cost of harvesting reduced fifty percent. Threshing is finished two days after the cutting ends.

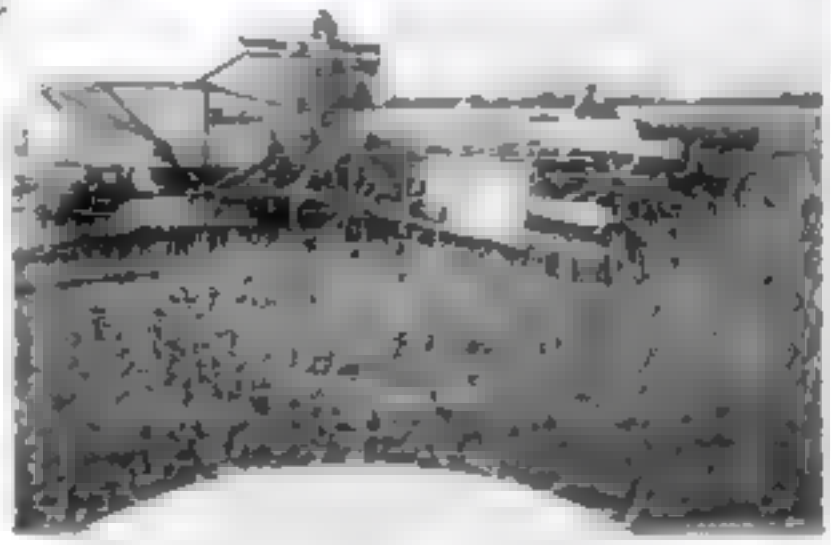
CAMPBELL is a pioneer in industrialized farming. He uses no horses. His methods, he declares, are applicable to any farm with 160 acres of grain. Indeed, power and machinery are rapidly revolutionizing grain harvesting on thousands of farms. New types of combined har-

A stationary tractor-operated threshing outfit on the 40,000-acre wheat farm of Thomas D. Campbell, operated in a section where use of the binder and combined harvester and thresher was not practicable. This Montana farm set a world's record by threshing 4,321 bushels of wheat in a day



This army 'foot walk-sow' travels three miles an hour and tends 50 acres a day on the huge Campbell wheat farm in Montana. At right: A combine harvesting soy beans

vests and harvests cut and threshes as they go. Where combines are used they do the work that formerly required twelve to twenty. The grain is threshed over wide swaths in a few days and one to three men with their wheat are gleaned to the acre. The farmer is saved fifteen to twenty cents a bushel in harvesting costs, possibly the difference between profit and loss.



Tractor drawing and operating corn picker and wagon which latter is filling. At right: T. D. Campbell, agricultural captain of industry

THE combine is being used not only for wheat, but to gather oats, rye, barley, sweet clover, soy beans and grain sorghums. It represents the greatest mechanical contribution to the reduction of farm costs since the tractor came into use.

Invention likewise has made vast reduction in the labor of raising corn. The tractor plows and fits the fields, two-row cultivators stir the soil and destroy weeds, supplanting the old walking cultivators and the hoe. At the Iowa Experiment Station even six-row cultivators have been used successfully.

"The corn harvest on my farm," said E. L. Ketzenberger, whose land is in northwestern Ohio, "used to be a hot and heavy job. We had to cut each stalk of it by hand and carry an armful at a time to the shock. Later the ears were husked by hand. Now my picking machine does the work of five men. This machine glides across the field behind a tractor. The fallen stalks are lifted, the ears snapped off and carried over rollers that clean off all the husks, after which a carrier delivers the ears to a wagon hitched to the same tractor. At the crib an automatic dump unloads the wagon and a carrier lifts the ears into the crib. No hand operations or heavy muscular labor are employed, from plowing to storing the harvest."

For haying, tractors are made now with mower attachments that swiftly cut wide sweeps. A side delivery rake stirs the hay to hasten its curing, then heaps it into continuous swaths. Over these the tractor pulls a wagon upon which the loader delivers the hay. At the barn a power hoist, in conjunction with slings or double harpoon forks, swiftly lifts the load and, suspended on a steel track, it slides back into the mows. A wagon may be unloaded in five or ten minutes. F. W. Chase, a Pawnee County, Nebraska, farmer, requires only two hours to cut, cure, rake, load and store an acre of hay.

The dairy farmer no longer must milk each cow by hand a spoonful at a time. To two or six cows at a time he attaches the pliant "cups" of a milking machine that does the work by suction.

"The milking machine," says L. D. Orr, of Indiana, "enables me to milk my twenty-two cows in two hours. By hand it would take two of us four hours a day each."

Much hand labor remains necessary in the production of vegetables, yet the large truck grower plows and fits his ground with tractor power. The small grower uses the garden tractor, a small motor-driven machine. Large unit sprayers and dusters fight insect pests. Overhead irrigation by perforated pipes overcomes irregular rainfall and makes certain a plentiful crop.

Potatoes are cut for seed by machine and planted by machine. A digging machine and a mechanical sorter prepare the crop for market. Tractor cultivation and power spraying and also in the orange groves and apple orchards.

OF THE great American crops, cotton alone has held out against the inventor. Over most of the South the patches are still plowed by mule power, thinned by a hand hoe, and picked boll by boll with human fingers. The first successful agricultural use of the airplane, however, has been for applying calcium arsenate to cotton to destroy the boll weevil. The airplanes dust 800 to 1,000 acres an hour.

A better conception of a modern midwest farm's equipment may be obtained by examining an actual farm. A. S. McDonald and his son operate near Peoria a typical up-to-date Illinois farm of 470 acres. Their major equipment includes a heavy plow tractor, a smaller tractor that can make short turns and is adaptable to almost any task where horses could be used, mower and cultivator attachments, a power hay hoist, a tractor-pulled binder, wide disks and harrows, a cultipacker, limestone crusher, endgate lime sprender, grader and ditcher, concrete mixer, grain separator, grain dump and elevator, clover huller, ensilage cutter, electric light and water system, straw spreader, feed grinder and various motors necessary for pumping, grinding, concrete mixing and other purposes. Of course, his automobile and radio should be included. Practically all farmers have motor cars, and about a fourth—1,252,126, according to Department of Agriculture figures—have radio sets. About one farmer in ten has a tractor.

"IN DECIDING whether to install a new machine," says McDonald, "I balance the investment against the labor the machine will save and the timeliness it will gain. The profit on a crop often depends upon getting it

(Continued on page 137)

He Trapped *Three* Bandits *with a* Microscope!

A Chemist's Great Man Hunt with Three Grains of Salt

By Edwin Ketchum

ON A night in October 1923, Southern Pacific Express Train No. 13, speeding southward across the Klamath range in Southern Oregon, had just entered the Siskiyou tunnel near the California border, when bandits crawled forward on the locomotive tender and covered the engineer and fireman with revolvers. Forcing the engineer to halt the train, they shot both men down in cold blood. Then they blew up one end of the mail car with dynamite, killing the mail clerk. A brakeman they killed with another bullet.

When police arrived, the bandits had escaped into the mountains without their booty. Four innocent men had been murdered, and the only clue to the slayers was exactly three grains of salt!

These were in a burlap bag which had been wrapped around a shoe of one of the bandits. The burlap had been painted with pitch from a fir tree, apparently to destroy scent in case of pursuit by bloodhounds.

Sherlock Holmes up to date: Edward Oscar Heinrich, chemist-detective, trailing the Siskiyou train bandits in his laboratory

Several days later a chemist bent over a microscope in a laboratory at Berkeley, Calif. He was Edward Oscar Heinrich, an expert in criminal investigation, a former police chief of Alameda and an instructor in the University of California. The object of his scrutiny was the three bits of salt. And, building step by step from what they revealed under the microscope, he was able shortly to emerge from his laboratory with the startling announcement:

"ONE of three men who committed this crime was a left-handed brown-haired lumberjack, not more than twenty-five years old, about five feet eight inches tall, thick-set, fastidious in his personal habits, clean shaven. He had recently been working in Northwestern Oregon or Western Washington in the camps where fir trees are felled!"

Experienced detectives, incredulous at first, lived to be convinced. For today, as the result of that remarkable description, and after a four-year man hunt extending to many corners of the world, the three bandit-slayers—Hugh, Ray and Roy d'Autremont — are in the Salem, Ore., penitentiary, beginning life sentences for murder. Hugh, almost perfectly fitting the chemist's first description, was captured early this year in Manila where he was serving in the Army. In June his brothers, twins, were caught at Steubenville, Ohio. They confessed their part in the train holdup, though blaming Hugh for the killings.

And all from three grains of salt! How was it possible?

To begin with, chemical analysis revealed to Heinrich that the salt was of a peculiar variety used in artificial salt licks for cattle. Following this lead, he visited several cattle ranches. Near one of these, and close to a salt lick, he came upon a cabin hidden in a deep canyon. Within were scattered fragments of burlap of the same texture as that picked up at the scene of the crime. These, likewise, were stained with pitch from Douglas fir trees, which grew about the place.

In the cabin, too, Heinrich found a towel on which were comparatively fresh wipings of hair and lather from shaving. Studying the hair under a microscope, he determined that the towel had been used by three different men. Then, comparing the shavings with standard tables showing the condition of human hair at various ages, he learned that all of the men were under twenty-five years old. Moreover, bits of skin from the towel showed that the men were of light complexion and of probable Latin ancestry.

Another search of the scene of the crime brought to light a pair of overalls. More grains of salt in the pockets and more pitch stains gave evidence that they had been worn by one of the bandits. They indicated to Heinrich also that the fugitives were woodsmen, for the owner of the overalls had worn them over the tops of his three-quarter boots instead of tucked in, as cattlemen and farmers wear them.

FROM their size and cut, Heinrich likewise estimated the stature of the wearer. And, from the location of pitch stains on the overalls, he reasoned that the wearer was left-handed. Fitting of many finger nail parings led to the conclusion that the man was scrupulous about his appearance.

It remained now to find the man answering the description. A bulge in a pocket of the overalls showed that a revolver had been carried there. Eventually a revolver was found in a clump of brush near the cabin.

The revolver was traced to a dealer in Oregon, whose records showed he had sold it to one "William Elliott" a short time before the holdup. Comparison of marks in the gun barrel with those on the murder bullets established that this was the weapon that had killed the trainmen.

Detectives traced "William Elliott" to a little house in Eugene, Ore., where lived the father of the d'Autremont boys. Additional evidence—hair, bits of cloth, finger prints—gathered in the d'Autremont cottage and examined by the chemist, established the identification.

Photographs and descriptions of the brothers were broadcast throughout the United States and in other lands. Rewards were offered. Months passed. And then, one afternoon at Manila, an infantry sergeant stepped before a private, stripped him of his arms, and sent him to the guardhouse. The private was Hugh d'Autremont. A few months later Ray and Roy were arrested in Ohio.

What's *at the* Top *of the* Sky?

Aerial Explorers Pierce Mysteries of Vast Upper Regions—How It Feels to Look Down Eight Miles!

By ALDEN P. ARMAGNAC

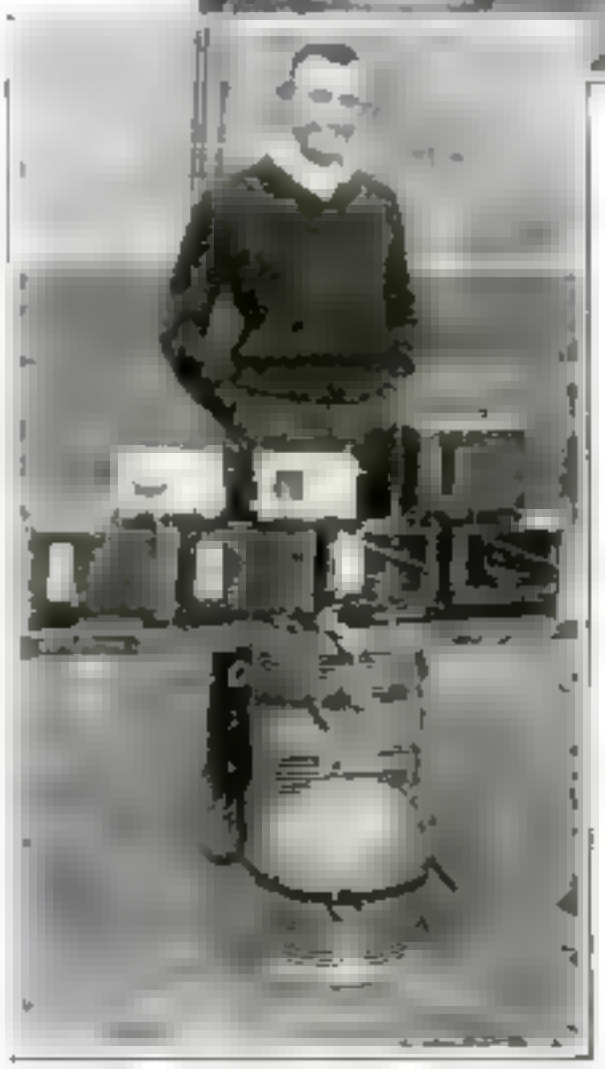
AT A flying field in Illinois the other day a pilot climbed into the basket of his balloon and swung aloft, up to the clouds. Shortly after he gazed at the face of earth through the one remaining clear spot on the left side of his frost-coated goggles. He was more than eight miles above it—higher than man had ever flown before!

Thus Capt. Hawthorne C. Gray, with a new world's altitude record of 42,470 feet, blazed a trail into the greatest unexplored region of all. Above your head as you look upward is a mysterious area that would swallow seventy times the ice-caps and glaciers of the earth. Explorers have traveled thousands of miles to reach the poles, and successful ones have had to penetrate only a few miles straight up, and even then they have been turned back. Five or six miles—as far as a mountain walk, perhaps—this is the distance that most have ventured into the baffling void.

Among the clouds. A remarkable aerial photograph of a plane climbing to the upper reaches of the stratosphere, taken from a dirigible

WHAT is there, out beyond the earth where the electric aurora flashes, and meteors wink to incandescence? Is it a dead world, frigid and empty, or teeming with perhaps some strange kind of life we do not know? What unknown terrors, besides the very real ones we have learned, await the venturesome aeronaut who would pioneer into the thinnest of thin air?

Foremost among aerial explorers has been Lieut. John A. Macready—like Capt. Gray, of the Army Air Service. It was he who recently told us how the earth looks to one soaring above three fourths of its air. Repeatedly the special Government-built altitude plane XCO5-A has carried him seven miles high, and on one occasion he reached what is termed the "critical zone" at the [illegible] mark of 35,000 feet.



What altitude flyers carry to bring back upper air records. Lieut. J. A. Macready, above, took these instruments up seven miles. His oxygen tank is seen with them

Last year a French aviator, Jean [illegible], took off from Le Bourget flying field at Paris and bettered his own altitude record, rising in his biplane 40,820 feet.

Balloons, too, have gone before on epochal voyages above the clouds. As long ago as 1901, two German aeronauts, Suring and Berson, attained a height of 35,424 feet, a record for [illegible]-carrying balloons that stood until Capt. Gray's flight.

Though unmanned "sounding" balloons have risen higher, Gray's is the greatest altitude that has ever been reached by a human being.

"At the top of my balloon flight," Capt. Gray told me, "I experienced a feeling of detachment, as though I were in a world of my own. I saw the earth at a great distance, swimming in its sea of clouds. How much of it might have been visible I cannot tell, thin cirro-cumulous clouds made a distant view impossible. Above, the sun shone brightly in a sky of the deep blue color well known to pilots who fly above ten thousand feet. The air at the top was extremely cold. My thermograph registered sixty-seven degrees F. below zero."

ON A clear, wintry day, says Lieut. Macready, the view of the earth through the cloud-free air is a magnificent panorama. Cities and towns become infinitesimal pin points upon the vast "skyscape" and one could imagine himself a superior being looking down upon the work of Lilliputians. At great heights above McCook field, at Dayton, O., Macready could plainly see the distant cities of Indianapolis, Cincinnati, Columbus and Toledo, and their dark smoke trails, against a snow-white earth.

It was thought that the clear upper air must render the sun a blazing beacon, the sky inky black and stars brilliantly apparent. "There were no stars," Macready reported, "but the atmosphere was very bright, the sky having a tinge of blue"—a fact confirmed by Gray.

THESE are observations snatched from the upper void under every conceivable difficulty and hazard. Men who go into these frigid regions find their minds wandering, their lungs not working. Half of the world's air lies below the three-and-a-half-mile level, half of what remains, in the next such distance. Up where Capt. Gray saw through clouded eyes the first eight-mile-high view, his barograph proved the air more than five times thinner than that on earth! Like all altitude flyers, he carried oxygen to sustain his life in the void. But even then a pilot's lungs do not function normally. His brain becomes foggy, and the least exertion causes acute distress. If his oxygen should give out—

The insidious thing about running out of oxygen is that there is no gasping for breath, no danger signal to warn the pilot. The figures on his instrument dials gradually grow blurred, but he thinks nothing of it; for his mind is wandering. The clock seems to stop, the altimeter to run backward. Over the nose of the machine the horizon of clouds wobbles, swings to and fro. The earth, infinitely far away, does not enter into the matter at all. A terrible weariness overcomes the pilot. He is angry, too—

dully angry that he should be up here alone, flying it seems, for countless hours, with everything getting darker. . . . Then oblivion. the plane tilts on end drops like a plummet out of the sky. With luck, the pilot may revive in time to right it.

That happened to Major R. W. Schroeder, another altitude flyer of the U. S. Air Corps. Headed before Macready of the "double crown," as airmen term the all-time record, he had reached a height of 33,000 feet when his oxygen gave out. Six miles down the longest fall on record—and he came to in the nick of time, to right his plane and make a perfect landing.

Men have risen in balloons and planes to 40,000 feet or more. But their planes would not operate above 33,000 feet, although engineers believe they have now found a supercharger to fool the thin air. At its "ceiling," the top limit of its flight a plane wallows with its wings and propeller slipping through the thin air—unable to "take hold."

Far better off is a balloon—even one as large as Captain Gray's, that was buoyed up by 80,000 cubic feet of hydrogen gas. Even before it reaches a "ceiling" where the outside air is as light as the hydrogen, it refuses to carry the pilot's weight any higher.

When new altitude machines are built, another danger awaits the next record breaker. Perhaps human beings have a "ceiling," too. They were made to live in an atmosphere that presses with a weight of fifteen pounds on every square inch of their bodies. Take them up where there is almost no pressure, and anything may happen.

"Macready to Explode for the Benefit of Science," was the headline that startled the airman shortly before his record flight. He hastened to disclaim any such intention. The height he reached produced only slight discomfort, but greater altitudes may prove more serious.

"Unless some artificial aid is devised," says Macready, "this will probably form the barrier which will eventually limit man's upward flight." The Army Air Corps tested a "pressure cabin"—a barrel-shaped affair built into the plane. Compressed air filled the cabin from a wind-driven pump; and the relief valve that lowered and regulated the pressure failed to work. Just in time to avert a tragedy the pilot landed and mechanics pried open the door the air pressure had clamped shut. The device was discarded; but other inventions may still solve the problem.

IF THERE are living things, birds or insects, that can dwell in the icy void [illegible] the earth, no trace of them has [illegible] found. The present altitude record for any living thing except man is thought to be that of the "choughs," or Alpine crows, that explorers saw flying near the summit of Mount Everest at a height of 27,000 feet. And the highest-dwelling creatures in the world are probably the "minute and monstrous black spiders" seen on the same peak at 24,000 feet.

"No indication of bird or insect life was noted," said Capt. Gray, after his record balloon flight. But he pointed out that his observations were limited to a clear spot the size of a nickel on one of his goggles. On his next trip he expects to make elaborate observations and to take photographs. Another airman, Lieut. G. W. Goddard, also intends to take a special camera eight miles high, and to take pictures that will surpass the 30,000-foot record photo made by Macready and a companion over Dayton, Ohio.

The upper air, lit by the aurora's flashes, is a queer place. Its dust is the dust of meteors; into it rise smoke clouds from volcanoes, sometimes forty miles high. No matter what storms may be raging on earth, the region between 25,000 and 30,000 feet is calm; beyond it its terrific winds sometimes sweep through it.

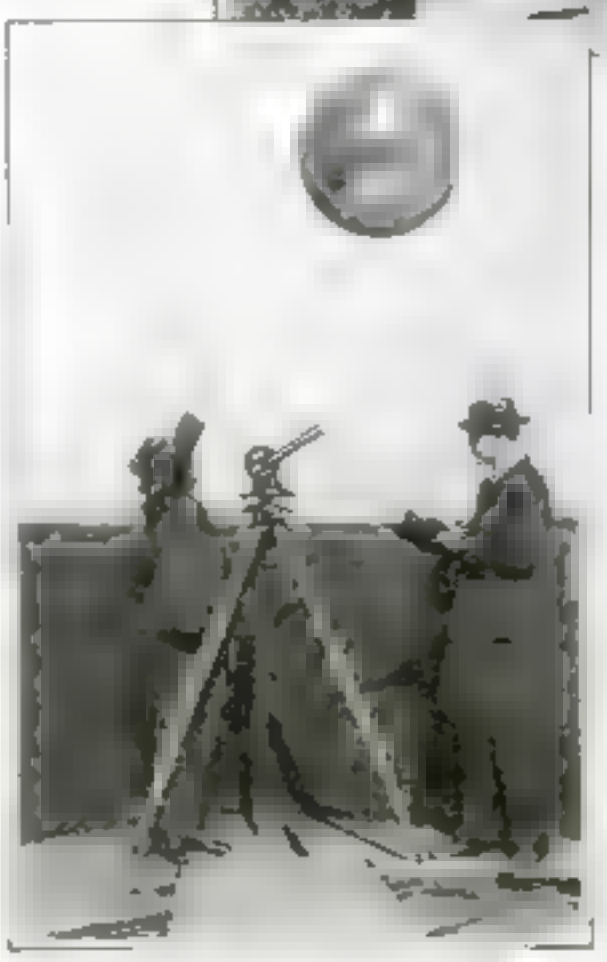
Though one "sounding" balloon recorded a temperature of 133 below, eleven miles above the equator, the altitude pilot is burned by the sun's ultra-violet rays unless he coats his hands and face with grease.

Greater heights than man has ever reached yield their secrets to the "sounding" and "pilot" balloons, sent up here and abroad. In this country the U. S. Weather Bureau now has established forty-three balloon stations where regular observations of the upper air are made. Eight-layer weather maps are prepared as an aid to aviators. "Sounding

(Continued on page 138)

Captain Hawker [illegible] Grey [illegible] making a flight [illegible] Baltic Sea [illegible]

Right, Jean Callizo, French flyer who is among the few men to reach the air's second layer. He made [illegible]



Launching pilot balloon to explore upper air currents. Some reach twenty-mile altitudes. They are watched through a theodolite

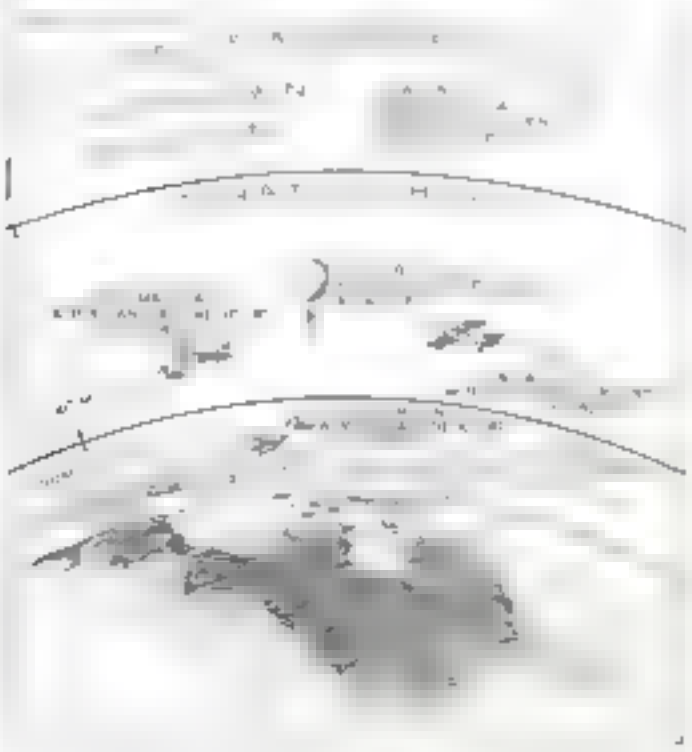


Chart showing successive layers of earth's atmosphere and records made by various altitude flyers

Whirling Wheels

The Story of the Automobile Age—A Vivid Novel of Youthful Genius in the Race for Invention

By EDMUND M. LITTELL

Author of "Midge" and "Fire Shy"

Illustrated by B. J. Rosenmeyer

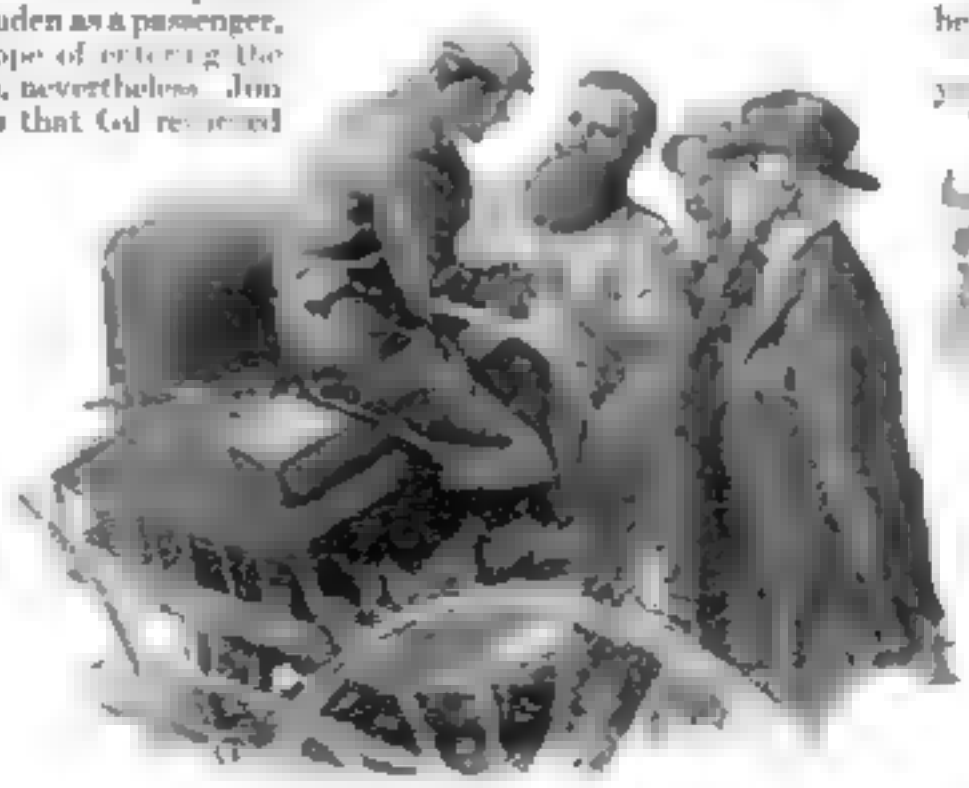
WHEN Gil Herrick, a young mechanic fresh from apprenticeship in Massachusetts, drifted into the village of Wendenville, Mich., he also drifted unwittingly into a feud with big Jim Wenden, the town bully. There were reasons for rivalry. First, Gil refused to be bullied, second, there was a blue-eyed girl, Abigail Caswell, and finally, there was a matter of speed supremacy.

Gil met the bullying in a quiet way that was disconcerting. Moreover, he found an unexpected champion in Jim's father, old Zach Wenden, the influential village blacksmith. As for Abby, Jim regarded her with a sense of proprietorship, and it did not lessen his animosity toward the newcomer to know that Gil was quartered as a lodger in the Caswell house, where lived the girl and her proud Boston-bred mother, even though Mrs. Caswell saw to it that the strange "mechanic" and her daughter were never left alone together.

The speed rivalry grew from the time that Gil began tinkering secretly in a small workshop he had set up in the Caswell barn, and established a bicycle and repair shop in the village. Word leaked out that Gil was building a motor wagon. Jim publicly scoffed at the "inventor", then, by his insistence, drew Gil into a bicycle race. Gil won; and when Abby handed a bunch of flowers to the victor, Jim's bitterness increased.

With a motor wagon race scheduled for Chicago, Gil rushed his machine to completion. The first public demonstration, with Zach Wenden as a passenger, failed dismally, ending his hope of entering the race. But he went to Chicago, nevertheless. Jim went also. The outcome was that Gil returned with new ideas for improving his machine, while Jim brought back word that he had purchased a new Benz motor wagon.

Months later, a forty-five-mile motor-wagon race between the rivals was a great event in Wendenville. This time Jim, with his foreign machine, won. But this time Abby ignored the victor. "Where's them flowers?" demanded Jim. And when she offered none, he attempted to steal a kiss, instead. The girl struggled in vain. Gil flung himself upon the strong-armed bully, only to be caught in the grip of a hammer lock. Gil jerked desperately, his arm snapped, and he fainted—but not before he had struck one last futile blow. In the eyes of the crowd and of the girl, Jim, in his victory, became the loser. Now read on.



Gil found it hard to leave Wendenville. Old Zach Wenden tried to express the feelings of the town: "Any time you want to come back, Gil, you can have about anything you want here. An' if you see Jim, tell him he'll have to hustle"

GIL came up out of unconsciousness that evening long enough to discover himself in his own bed. The white moustache of Dr. Simms was above him, the black beard of Zach Wenden at one side of him, the teary eyes of Abigail on the other. Then pain shrieked through him and he went out again. After that came a blurred awareness of confused events until hours later when he woke up, relaxed as from a long sleep. His left arm was bound to his side, but otherwise he felt strong. Then he heard voices, downstairs, arguing about . . . him.

Mrs. Caswell's sharp voice, and hers. "Gail," that's what he would call her. Didn't like "Abby" at all. Her voice was clear and strong with a deadly earnestness, her mother's harsh. Their talk was confused at first, but he listened shamelessly to the interlocking sounds because his name was being used, and gathered some little sense out of the jumble.

"I won't go!" That was Gail. "I'm going to stay here with Gil."

"But he's only a grease-covered mechanic with nothing to his name!" That was Mrs. Caswell.

"He loves me, doesn't he? Didn't he fight for me?"

"Only made a fool of himself, and you too."

"I don't care; I love him, and I'm going to stay!"

"If you do I'll cut you off without a penny."

It was heated, furious, terrible. Gil scrambled out of bed as best he could and struggled into some clothes. Funny how weak he felt, when a moment before he had surged with strength. Dizzy, too. He crawled downstairs.

"Gil, you mustn't!" It was Gail, running to him as he staggered in the doorway. "Go back upstairs!"

"I want to hear." His voice wavered strangely. "You're talking about me."

"Indeed we were. And

"What [illegible] you waiting for? Jim asked. Myself. [illegible] Herrick Ruttenber

this is as good a time as any to—"

"Mother, you be quiet! Shame on you! Sick and weak like this—and you—"

"After all I've done for you!"

"And all you've made me do for you the last two years—"

"Gail, I—I am tired."

IT WAS anything but pleasant, the talk that followed her leading him to a chair, nor was it finished then. But by the time he was strong enough to go back to the shop, where the townfolk greeted him with a new resonance of liking and respect in their voices, he knew the whole story. Mr. Caswell, it seemed, had not left a complete wreck behind him, there had been a very comfortable residue after everything was figured out. With that, Mrs. Caswell was—of course—returning to Boston. The bitter words that Gil had heard were a struggle between a mother who loved in her own peculiar way and a daughter who refused, now that the issue was there, to abandon her new-found lover.

With Gil present as a third party to the conferences, some sanity was achieved in the discussions, though Gail remained as stubborn as before, until Mrs. Caswell wept—not a pleasant sight when one of her cold restraint broke into harsh and wracking sobs; then Gail wept, too. She hadn't really known that her mother loved her, and said so, with a questioning, fearful glance, when she had returned from nursing her mother into bed.

"What shall I do?" she whispered. They were sitting on the front porch, Gil's arm tight about her. "She—I—can I leave her now, Gil? I didn't know."

"She'll have Boston," Gil said. "And if you go I'll be alone again."

That recalled her first comment about him. "An orphan," she had said. She twisted about to assure him with warm, fierce caresses, that he should never be that way again. "Even if I do leave you, just for a little while . . . 'Gail, I love it. How did you come to think of that?'"

"It's like you—Gail."

"I hate 'Abby.' I'm not a cat, am I? When did you know you loved me? And will you always—"

Then, after a long time, back to her mother again. "Gil, dear, don't you—can't you—it's so selfish to leave her now, when she's going home after so long. We're so young and she—why, she's old! Wouldn't it be selfish to let her go alone?"

After many such talks it was so agreed. "You can work, oh so hard!" and "I'll have to; I've got to."

Mrs. Caswell, restored to her normal state of mind, hastened preparations for departure with a triumphant light in her cold eyes. She may have failed to restrain her emotions once, but that momentary weakness had given her a victory. Gil and Gail were planning to be married "just as soon as mother is settled," but—so much can happen when lovers are separated. They parted, Gail in tears at the station, her mother almost vivacious at the prospect of Boston, Gil quiet but with eyes that spoke volumes. Can steel-gray eyes be warm? Gail knew, and summoned their message in later days when letters were overdue. For Gil drove himself through four years of work before he saw her again.

Four years, with Jim not there to jeer, but with his taunts still ringing in his ears. For Jim had left Wendenville very soon after the race. He had blustered and laughed at the coolness of Wendenville for a while, called and apologized to a quite indifferent Gail, then had climbed into his wagon and driven away.

"You don't know so much about motor wagons, do you?" was the way he apologized to Gil before he left, and Gil looked up from his work bench with eyes as hard as marbles.

"Well, I made one, didn't I?" said he. "I didn't buy it. And I finished a race without pushing."

Jim laughed. "Well, pleasant dreams with your pencil and paper," he drawled. "I'll come back and wake you up one of these days."

He did, in the fall, looking the prosperous city man and making much talk about what he was going to do.

"Some folks think they got something with this here hydrocarbon engine," he said in the post office. "Ain't been to the city, where electrics are so thick on the streets you can't walk without gettin' run over. I'll be makin' electrics when some fellers are—"

"WHO put that idea in your head?" asked Gil, and some of his friends laughed.

"Come down to New York some day," drawled Jim. "I'll show you a factory that's turnin' 'em out like sausages."

Soon his father permitted it to be known that Jim had sold his farm and bought into a company that was manufacturing electrically driven buggies—and Gil went to work.

Four years, with Gil quietly calling attention at various times to the events that were going on in the world outside. Electrics? When Barnum and Bailey's circus that very year put one of Duryea's wagons at the head of its parade and plastered the country with signs showing it? Electrics, when the following year

"Gil, you mustn't! Go back upstairs!" It was Gail, running to him as he staggered in the doorway. "I want to hear," he said, his voice wavering strangely. "You're talking about me"

Alexander Winton drove his gas engine runabout from Cleveland to New York in less than ten days? When, in '99, Haynes-Apperson made a trip from Kokomo to New York in twenty-one days, only ten of which were driving days? Suppose electrics were in the ascendancy in cities, suppose they were dominating the bicycle shows where they were being exhibited, they were at the mercy of charging stations and never could get far away. Gil proposed to perfect a vehicle that could go anywhere, that could refuel itself at any wayside drug store. And big Zach, combing his beard, said "Um-m-m" and watched Gil go.

Four years. Not too long in which to devise a better means of making rear wheels turn, not too long to arrive at a more reliable method of introducing a spark into a cylinder, to rebuild the entire running gear. Remarkably short, in fact, when the slowness of previous advancement was considered short too, considering that a living had to be made at the same time, for Gil was conserving his capital for a very definite purpose.

The jumping off of the drive belt had been caused by the different speeds of the rear wheels in making a turn. That meant that a compensating device of some kind had to be arranged, so, after many experiments, Gil drove the rear axle instead of the wheels, splitting it in the center and installing a clutch arrangement there, on the outside of which he placed a sprocket. This he drove with a chain similar to that of a bicycle, carried back from the crank shaft of the engine. The axles being live ones now, a housing for them was necessary, with ball bearings to support them. Because of excessive vibration in his engine he reduced it to a one-cylinder of the same Otto type, setting it horizontally pointing forward in a frame made of bicycle tubing. The sparking plug having come over from France he used it with dry cells and an induction coil to displace the cumbersome system of make-and-break that had supplanted the original hot tube method of Daimler's design.

Daimler? Who was he? Some of the boys wanted to know, and Gil recited a history. Did they know that men had been trying for centuries to make vehicles go under self-contained power? Well, they had. Way back in 1600 a man named Stevin put a sailboat on wheels and carried twenty-eight people along the shore of Belgium. Then Sir Isaac Newton made an engine out of himself in 1665, putting a chair on wheels and driving it with a hand crank. After that Watt found out what steam would do, and a man named Cugnot put a boiler on wheels in 1710, in France. Then great steam-driven things began to crush the roads of Europe and drive at terrific speeds—ten, fifteen miles an hour over the roads—until England passed a Red Flag Law which compelled every operator to keep a man in front of his vehicle with a red flag as warning. It was not until 1884 that one Gottlieb Daimler of the Otto gas engine works secured the compression of hydrocarbon gas in a small cylinder; 1889 before he had given it the two cylinders and four horsepower that Gil had used six years later.

Daimler had used a hot tube method of ignition, a metal tube heated by a Bunsen burner that gave a hit-and-miss explosion. That had been supplanted by the make-and-break, and now—the sparking plug. No danger of fire there, no call upon the driver to get out and bend a sparking lever with a fire beside the road. And with a movable brush on the crank shaft commutator, he could increase or retard the speed of his engine. For safety's sake Gil installed a governor to keep the engine at steady speed, and a cut-out arrangement whereby, on level roads, the engine could be released for racing.

Then he changed the wheels, going from buggy size to thirty four inch wire ones, with two-inch single tube pneumatics glued to the rims, as with bicycles. The only thing that remained unchanged after the four years' work was the original loads. That was something he could arrange for when he had achieved mechanical perfection.

"I've got a real runabout," he wrote to Gail at last. "And I'm going to move to Detroit. Most of my machine work has been done there lately, and there's an excellent foundry there, too, so it would be foolish to try to manufacture here. There's talk of a real automobile show in New York this coming November. The Automobile Club of America is arranging for it and it will be one where they show automobiles only, no bicycles. If I can get my model finished in time, I'll exhibit. Then I'll come up to you!"

Wendenville was hard to leave for the last time, and Wendenville hated to see him go. Even the horses of the countryside no longer shied at him and his fearful chariot. And old Zach Wenden—he was shrewd, old Zach—saw behind Gil's plugging, more than just an effort to make something new. He saw a spirit of "show Jim up or bust"—and he tried to express the feelings of the town, his great voice buzzing warmly.

"Any time you want to come back, Gil, you can have about anything you want here. An' if you see Jim, tell him he'll have to hustle."

His great hand was crushing Gil's almost as much as Jim's had done, but above the black beard a pair of eyes glowed warmly, not ruinously. Gil said nothing, only swallowed, and nodded, and tried to return the squeeze. Then he kicked free the ratcheted clutch pedal, pulled back on the short hand lever that rose out of the right-hand side of the seat, and was gone. A fine bunch of folks, those who stood there wishing him Godspeed. He shoved the lever forward, and the higher speed of the planetary transmission took hold. A fine town, Wendenville.

"Reckon you won't ever need any help, lad," Zach had said, "but if you ever do—"

DETROIT, the city founded by a Frenchman, where Canada lies south of the United States. Extending along the river between the lakes like an opened fan with some of its tree-shaded streets the ribs. City of great stove factories, settled folk of family who lived sedately and were quite averse to the few noisy things that ran through their streets and frightened their sleek horses. Gil had thought of Cleveland first, for Winton's spectacular achievements with his racer were causing many eyes to turn that way. Winton had established records for speed that began, only sixty days after the organization of his company in '97, with a mile on a circular track in 1.48. He had made a second run to New York in five days, was entering foreign racing events—and selling runabouts as a result. Then there was the White Sewing Machine Company with its steam car, and Stearns with his gas runabout. But Gil's connections were already made, so he went to Detroit.

Out on one of those ribs of streets was (Continued on page 145)

When Neptune Scowls

How Tempests, Fogs, and Stealthy Icebergs Challenge a Mariner's Skill—Queer Mishaps of the Sea

By JACK O'DONNELL

How a Mediterranean rock wrecked the bow of the new Orient liner *Orsova*, on her maiden voyage from England to Australia

SHARPLY to starboard careened the S. S. *Malolo*, largest and swiftest commercial craft ever built in America. A convulsive shiver traversed her hull. Below her water line, six thousand tons of sea water were roaring into her gashed hold. More than three hundred passengers stood, terrified, awaiting the inevitable call to lifeboats.

A moment before, the *Malolo's* geared turbines had been driving her through thick fog in a trial run off Nantucket, Mass. Just built in a Delaware shipyard, she was about to be placed in service in the Pacific. Then, without warning, up out of the mist loomed the Norwegian freighter *Jacob Christensen*, and the next instant the Norwegian buried her prow in the new steamship, twenty-four feet below the water line.

But the call to lifeboats never came. While the freighter, leaking badly, made for port, the *Malolo's* crew leaped into feverish activity. Pumps were manned, auxiliary engines started. Already the automatic bulkheads had swung shut. The ship's designers had averted the tragedy of the *Titanic*, sunk by an iceberg. Self-closing doors sealed off the torrent that was inundating the engine room and stoke hole.

A tanker and a trawler, followed closely by Coast Guard cutters and wrecking tugs, answered the *Malolo's* first S O S calls. Aided by radio direction finders, they raced to the rescue, only to find that no rescue was necessary. The disabled ship's passengers lined the rail and watched the salvage preparations with calm unconcern. the most serious part of the mishap, in their opinion, was that the stoppage of the engine put the ship's galley out of commission so that no hot food could be served. The boiler room crew made their first hot drink with the aid of blow-torches; later the trawler *Fisher*, standing by, loaded with fish for the New York market, sent over huge pans of steaming fish to the hungry passengers.

When the *Malolo* arrived at New York, in tow of powerful tugs, divers reported that the hull was rent by a gash twenty feet wide and ten feet long. The impact of the collision had even cracked a plate on the opposite side of the hull, as the freighter's keel had buried itself ten feet deep in the *Malolo*. That the liner should have floated safely for days after its terrific crash was the most amazing feature of the incident, and a tribute to the recent progress of marine construction. "It is unprecedented," said Admiral David W. Taylor, U. S. N., retired a passenger on the vessel, "to see a ship rammed square amidships and still afloat. We owe our escape to the lessons learned in the *Titanic* disaster."

The doomed crew of the Japanese ship *Raifuku Maru*, clinging to her bridge as she rolled over to sink off Halifax, photographed from the *Hoosac* which stood by, powerless in the tempest

THE remarkable escape of the *Malolo* was the result of one of those strange accidents which ever menace men who go down to the sea in ships. A vast majority of the casualties at sea follow the familiar rule of collision, explosion or fire, but there are enough unusual happenings such as the *Malolo's* close call to vary the monotony of shipwrecks and bring gray hairs to the heads of shipowners and marine underwriters.

Three days out of St. John's the schooner *Penhook*, Gibraltar bound, ran into some uncommonly dirty weather. By nightfall a furious gale was blowing across her slippery decks. The crew went about their duties with no concern, however, for the *Penhook* had ridden out many a gale in her day and was considered a competent little ship.

Lifeboat leaving the foundering *Ignacio Florio*, from which the *President Harding* saved all souls in an Atlantic storm

The hold of the *Ponkook* was jammed with dried codfish, just weighty enough to give the vessel some reassuring steadiness.

The rain came down in slanting sheets. The wind blew remorselessly. The seas ran high, pounding the little craft with unbridled cruelty. Her decks were awash. Then, shortly before midnight, one crashed down on her and smashed a hatch. Sharp commands followed that blow. Despite the devastating fury of the storm, men, held together by ropes, succeeded in closing the opening to the hold. But not before several tons of water had poured in to keep the codfish company.

That water lost no time seeping into the cracks of the boxed codfish. Immediately the codfish began to swell. The wooden boxes burst open, giving the water a better chance to work. As the fish swelled, the boxes on the outside were jammed against the ship's steel plates and burst, providing more fish for the water to expand.

THE captain knew there was only one way to relieve the pressure—jettison part of his cargo. But how? The air was full of flying water, the wind screeched. Wave upon wave looted the decks with unchained fury. Even if men could live on those decks long enough to open a hatch they would invite quicker disaster by letting more water into the hold.

There was nothing to do but wait and hope—hope that the codfish would absorb the water already in the hold before the expanding fish pressed against the ship's sides hard enough to loosen her plates.

Toward dawn the inevitable happened. The seams of the ship loosened and more water seeped into the hold. Gradually the water rose despite furiously working pumps. By nightfall the *Ponkook* was riding sluggishly through the heavy seas. Her head was bowed as if she were weary. Throughout the night she settled and preparations were made to abandon the ship in the one remaining lifeboat.

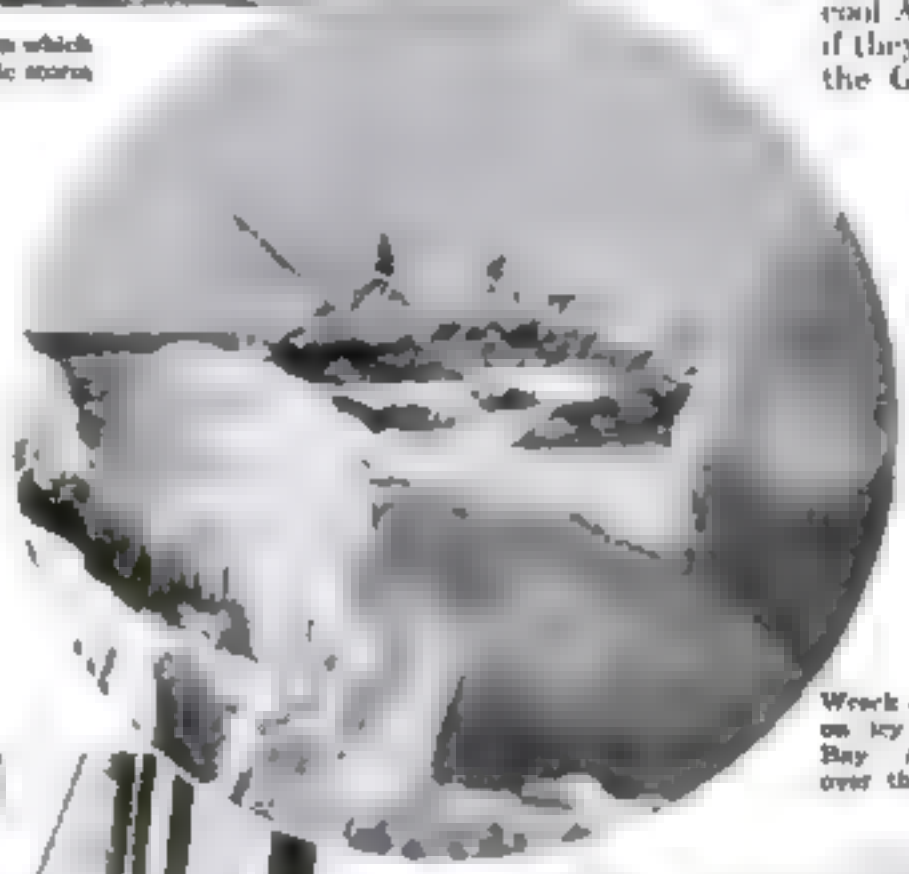
The storm abated about noon the following day just as the *Ponkook* was ready to go down by the head. She was sighted by a Norwegian steamer, the *Kronstad*, her crew taken off and landed a few days later at Galveston, Texas.

ONE shudders at what might have happened to the crew and 750 passengers aboard the Allan liner, *Grampian*, a few years ago, had not the captain of that ship thought and acted with superb rapidity.

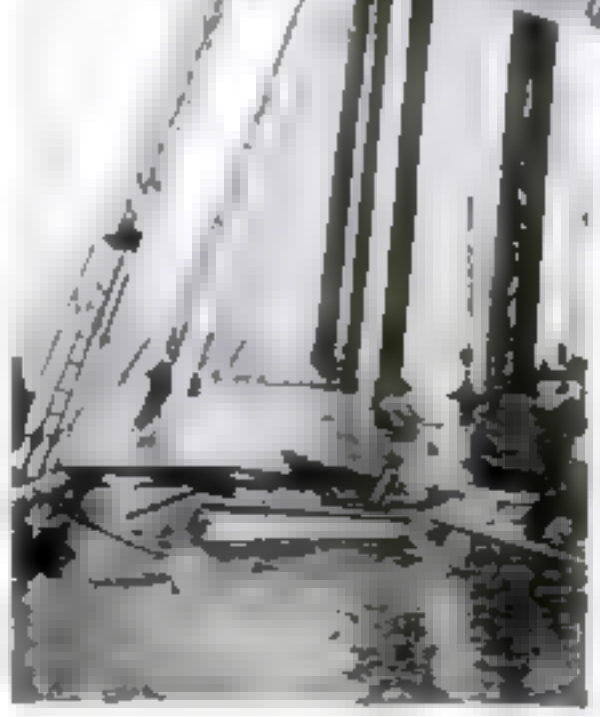
The *Grampian*, enroute from Montreal to Liverpool, was plowing through a moonlit July sea. Men, women and children were slumbering. Into their rooms through open portholes poured cool Atlantic breezes. What if they were off Cape Race—the Graveyard of the Sea? Was it not July, the midsummer season when Neptune lapses into untroubled sleep?

But navigators who know the north Atlantic never sleep. They live in a sort of terror of sea snakes. Icebergs. They never forget the *Titanic*. They never forget the ships before the *Titanic* which dis-

(Continued on page 115)



Wreck of a Coast Guard vessel on icy rocks of Narragansett Bay. A mate plodded barefoot over the snare to summon aid



All that remains above water of the *Ruth E. Merrill*, world's largest six-master which sank in Vineyard Sound, Mass., with 4,000 tons of coal aboard, while bound from Newport News, Va., to Portland, Me. She was one of the only three remaining American six-masted schooners, once numbering more than a hundred

It took forty hours to bring the crew of the steamer *Wiltshire* to shore in the breeches buoy after she was wrecked off New Zealand

Frauds Bared *by Strange* Detective Rays

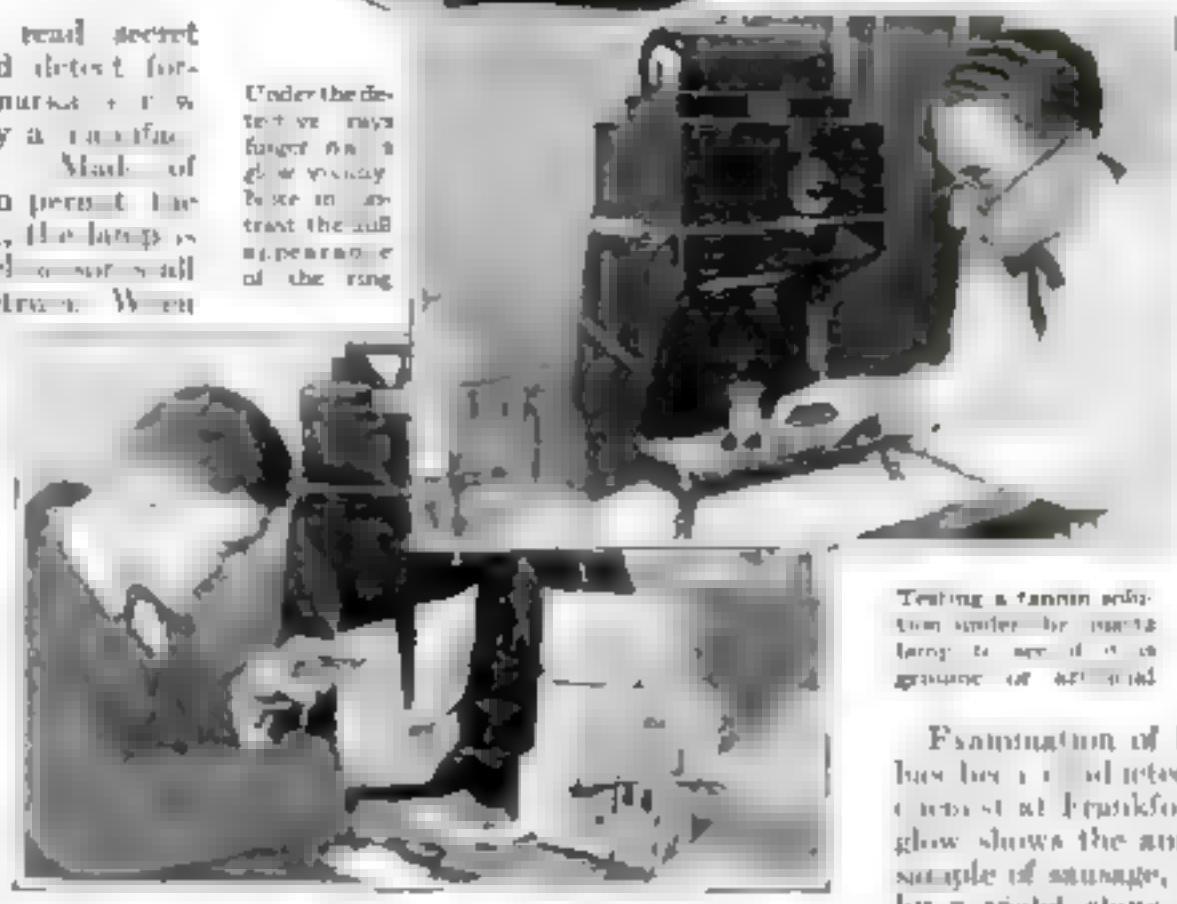
Forged Bank Notes, Adulterated Foods, Fake Silk, Exposed under Lamp Glare

INVISIBLE rays that read secret writing, test food, and detect forgeries issue from a remarkable new type of lamp developed by a manufacturer in Hanau, Germany. Made of quartz, instead of glass, to permit the passage of ultra-violet light, the lamp is equipped with a filter, which screens all the visible rays of the spectrum. When its powerful "black light" falls on any one of a huge class of substances, the substance "tells its story" by giving off a deep purple, green, or brilliant orange light.

Paper, for instance, glows with different colors under ultra-violet light, depending on how, and of what, it is made. The genuineness of bank notes or rare postage stamps is detected by comparing under the rays the ones in doubt with others known to be authentic. If one turns yellow, say, and the other blue, forgery is proved. Secret writing and erasures, too, glare out strikingly.

Artificial tannin—sometimes used to adulterate the vegetable tannin of the leather and dyeing industries, is revealed in tests devised by Professor O. Gressgross of the Charlottenburg Engineering College, by its brilliant glowing light under the rays. The natural tannin does not glow.

Examination of food by the new lamp has been conducted by Dr. Popp, legal chemist at Frankfort-on-Main. A bluish glow shows the amount of tendons in a sample of sausage, and decay is revealed by a violet shine. Natural fruit juices identify themselves. Wool shows a different fluorescence than cotton or silk.

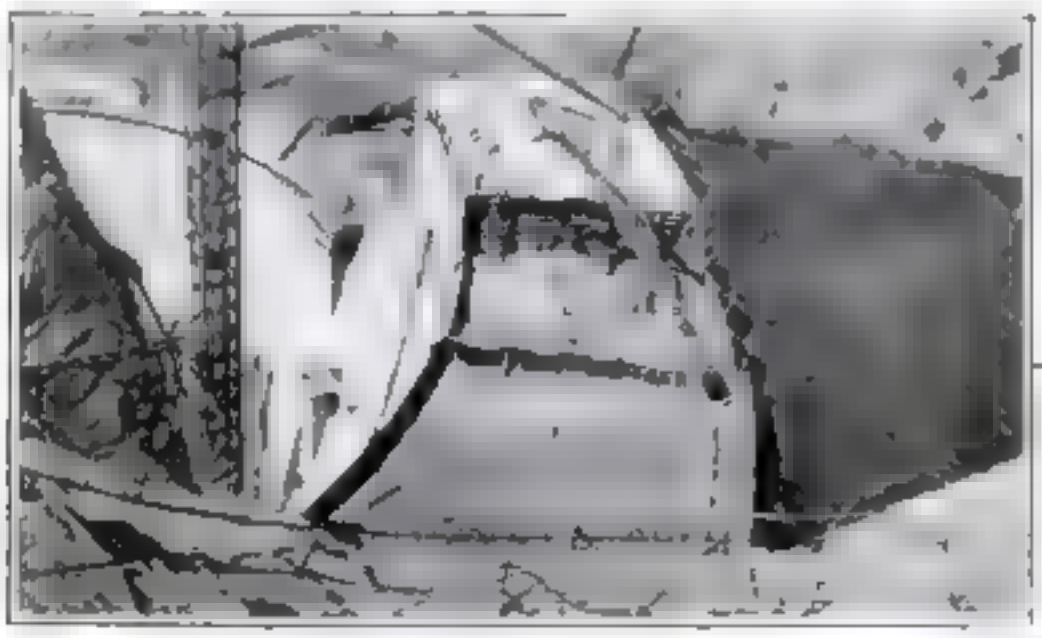


Under the detective rays forged bank note glows yellow in contrast the dull appearance of the ring

Testing a tannin solution under the quartz lamp to separate it to grasp of artificial

Bank notes being tested under filtered ultra-violet rays of the quartz lamp. Counterfeit money is instantly detected because it gives a glow of different shade from that of genuine bills

World's Highest Dam Turns Valley into Lake



Looking down on the Pacoima Canyon Dam in use of construction. Concrete, mixed on the mountain top, is poured down in chutes

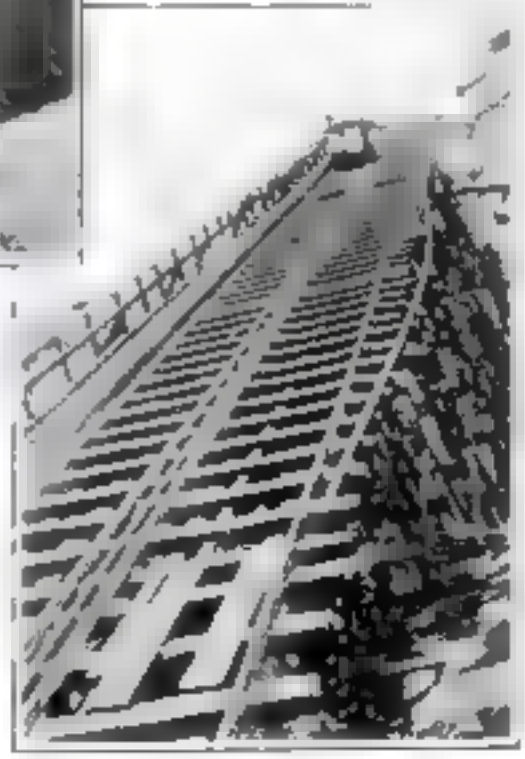
THE highest dam in the world is nearing completion at Pacoima Canyon, near Los Angeles, Calif. When it is finished, at a cost of $2,500,000, a short 380-foot wall of masonry will hold back the waters of a lake that will flood valley floors well up toward the structure's top. Impounded the water will bring thaws and rains, and release them when all danger is past.

Already its lower half blocks completely a narrow mountain gorge, the outlet to the natural basin between two ridges of peaks. Its upper half, when completed, will close the 800-foot gap across the valley and transform it into a huge lake—a storage reservoir of surplus water.

Rugged mountains surrounding the Pacoima Dam presented unusual problems to the engineers. Engineers conveyed materials straight up the side of one mountain by a novel tramway. At the top they mixed the concrete, then sent it down chutes to the dam in the canyon below. Enough concrete to pave ten miles of road more than two hundred thousand cubic yards—will go into its construction. Its base will be more than a hundred feet thick, its top, only eight.

Unusual strength must go into a dam of this extraordinary height, whose bursting would in itself precipitate a terrible flood. Contrary to popular belief, the force that is constantly seeking to overthrow a dam has nothing to do with the size of the lake behind it, this force depends on the dam's height alone. A dam twice as high as another must be eight times as strong. Imagine, then, the pressure the Pacoima dam must resist!

Other achievements in dam building are the 351-foot Arrowrock Dam in Idaho, the Hetch Hetchy Dam for San Francisco's water and power, others such as the 284-foot Roosevelt Dam in Arizona, the 328-foot Shoshone Dam in Wyoming, and the recent 330-foot Exchequer Dam in California.



Tramway built up mountainside carries concrete materials to top to be mixed and then "shot" to dam below

Unusual Ideas *Put to* Work

New Synthetic Lumber; Strange Fireworks of the Atoms; Surprising Discoveries about Men, Animals and Plants

Significant accomplishments in research and invention in many scientific fields that bear upon the daily interests of life, as well as upon its many problems, are recorded in these pages each month.

Your Capacity to Learn

"NEVER too old to learn" contains more scientific fact than fiction. In a recent series of experiments with persons of various ages, Dr E. L. Thorndike, professor of educational psychology at Columbia University, found that men and women approaching the half-century mark learn more rapidly than children, and almost as rapidly as youths of twenty to twenty-four years. Even persons over fifty years can learn new things.

In the learning of elementary school subjects, adults of forty-two progressed about five sixths as fast as adults of twenty-two. Both these groups learned more per hour of study than children comparable to them in natural intelligence.

Further experiments with adults learning algebra, science, foreign languages, shorthand and typewriting, led to the conclusion that the ability to learn increases in youth until about the age of twenty. Then, after remaining unchanged for several years, it declines very slowly.

"The chief reason why adults seldom learn a new language or trade," concludes Dr. Thorndike, "is not lack of ability, but the lack of opportunity or desire.

Flying Safety Increases

ALMOST everyone, these days, would like to fly. But first, just how hazardous is it?

An answer to the question that is on the lips of millions recently was supplied by Dr Frederick L. Hoffman, consulting statistician of one of America's largest life insurance companies, and it reveals surprising progress in flying safety.

On the basis of air mail records, the present risk is only one death to more than a million miles of flight. In the Army and Navy services the risk is one fatality to half a million miles. Hazards in commercial flying, according to Dr Hoffman, are diminishing rapidly as the area of operations expands. Recent legislation providing for inspection of aircraft and periodical examination of pilots, he says, will further increase safety.

In a test in London's Botanical Gardens these girl students are experimenting to determine the effect of ultra violet rays on tropical plants when transplanted to a temperate climate

Tiny Plants Tunnel in Stone

HOW a mole can burrow its way through hard-packed earth under the sod is always a source of wonder; yet there live creatures that actually can make their way through solid stone! These creatures are not sturdy animals, but living plants; so small you cannot see them without a powerful microscope.

That such amazing tunnel makers exist was revealed recently before the French Academy of Sciences. They belong to the tribe of algæ, like those that form the green scum on stagnant water. And they possess the unusual power of dissolving the rock on which they grow, provided the rock contains lime. Billions of them, growing along the seashore, are known to have eaten away huge limestone cliffs.

Tiny life such as this swarms all about us, unseen and virtually unknown, yet profoundly influencing the world we live in. Many lowly algæ capture carbon dioxide from the air, build it into their bodies and enrich the soil when they die. Certain soil bacteria serve as wreckers that tear down dead plant and animal bodies and return their substance to the dust for the use of growing things.

Can Animals Run Machines?

WILL animals eventually run our machines, relieving men of monotonous drudgery?

That startling possibility has just been suggested by R. J. Houssay, a French student of animal habits, as the result of

The "colorimeter" invented by Arthur C. Hardy (left) and Frederick W. Cunningham, of the Massachusetts Institute of Technology, makes it possible to match colors exactly. Here they are measuring the color of an apple, seen in front of the motor at the right of the illustration

As the earth cooled it shrank, its crust "buckling," formed mountains. Dr T. A. Link of the University of Chicago, reproduces this action in model mountains of concrete and plaster layers by the means of pressure applied with a jack and saws them for cross section study

fascinating experiments conducted by Claude Bussard, a young inventor associated with the Pasteur Institute in Paris. While studying the intelligence of lower animals, Bussard invented a machine which automatically performs the operations of animal training, as moving doors and making electrical contacts. The animal actually operates the mechanism which teaches it to perform a certain act.

If animals can thus train themselves mechanically, asks Rousseau, why may not trained animals be able to operate the machines of men? Their skill might be increased, he further suggests, by breeding races of animals for each task.

New War on Heart Disease

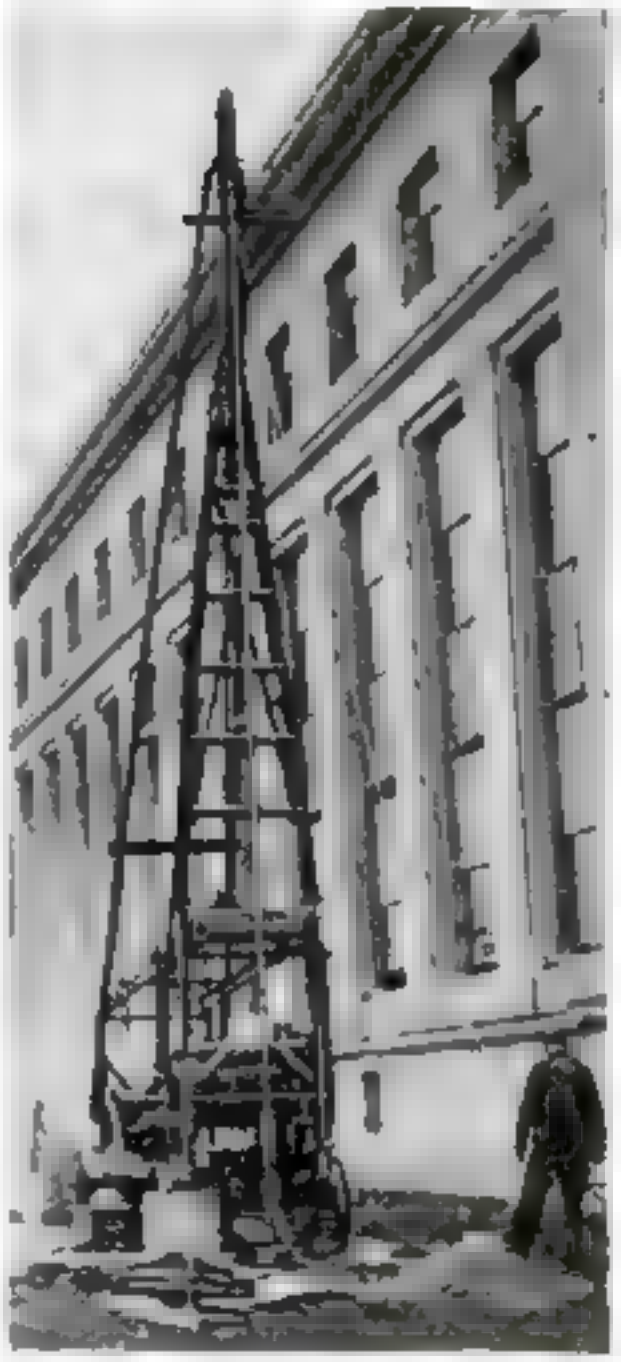
PHYSICIANS of the American Medical Association recently joined in a concerted effort to cut down the increasing toll of heart disease, which claims more victims in the United States than any other malady, being now responsible for one fifth of all the adult deaths. Doctors have advanced various theories. Dr Henry Albert, health commissioner of Iowa, believes heart trouble is one of the prices we pay for the increased span of life in the last thirty years. While maladies such as scarlet fever and rheumatic fever have been brought more or less under control, their survivors have been left with weakened constitutions. Scarlet fever brings heart weakness in later years, says Dr. Albert, while rheumatism is responsible for twenty-five percent of deaths from heart disease.

Fat persons are especially subject to heart ailments, according to Dr Stewart R. Roberts, of Atlanta, Ga. High blood pressure, goiter and disturbances of the thyroid gland have been cited as causes by other physicians.

Of first importance in treatment, physicians generally agree, are regular habits of living, rest and relaxation from strain.

Boards from Lumber Chips

MUCH the same method of explosion that produces puffed cereals for breakfast recently has been used in the manufacture of a lumber which, says the Smithsonian Institution, is stronger than natural wood. Waste wood chips are



Digging a hundred feet to solid rock, Massachusetts Institute of Technology engineers will place a bench mark to determine in time whether the ground above is slipping seaward

first exploded, then compressed into boards. The chips are made to absorb steam under pressure. When the pressure is suddenly released the steam expands, blowing the chips into fluffy fibers, which can be pressed into boardlike sheets.

Every Atom a Flashlight

MORE wonderful happenings in the tiny world of atoms have been discovered by Drs. W. H Crew and E O. Hulburt, of the U. S. Naval Research Laboratory, Washington, D. C., through their careful and extended study of light given off by hydrogen atoms.

The seemingly continuous glow that is observed in electrified hydrogen in a glass tube, they found, actually consists of myriad sparks of light so numerous that they all blend together. These little light flashes represent the disruption and recombination of atoms. In an amount of hydrogen the size of a pea, more than four billion billions of atoms go through this process and flash every second!

If everybody on earth were to light matches one after another as rapidly as possible, each person would have to light nearly five hundred million matches a second to equal the record of the atoms!

Approaching Synthetic Life

BELIEF that life eventually may be produced artificially has been strengthened recently by Sir Oliver Lodge, famous British physicist, and Dr. Daniel T MacDougal, of the Carnegie Institution of Washington.

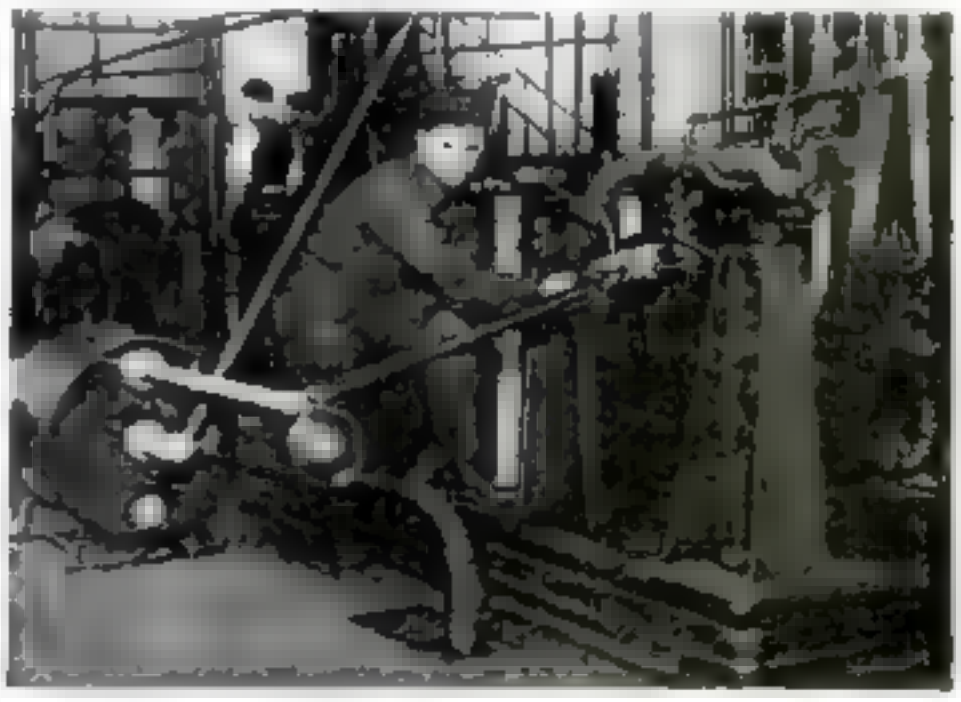
In a lecture at Oxford University, Sir Oliver said that many organic compounds found in living matter, such as sugar, already have been manufactured in the chemical laboratory. If such manufacture can be continued, he added, until a mass of artificial protoplasm is produced, that protoplasm may show vitality in some form of life.

Substantiating this view is an important advance reported by Dr. MacDougal, inventor of an "artificial cell" which behaves in many ways like the cells of living plants. He has produced a new cell which resembles living cells even more closely. This he has done by adding chemicals called lipoids, which are present in plants. The new cell will absorb chemicals in the solution around it, just as cells of plant roots absorb chemical materials from water in the soil.

Lights Controlled by Radio

A FORETASTE of the part radio may play in industry was given recently when Westinghouse engineers, with a working model, demonstrated control of street lights by radio waves, turning lights and groups of lights on and off at will.

T D. Kelley, London chemist, is mixing his inexpensive new alloy of earth metal oxides, called "solium," previously described in Popular Science Monthly. It is called a perfect substitute for costly platinum



The U. S. Bureau of Standards is testing the efficiency of illuminating gas as a possible alternative of gasoline as a fuel in motor cars. Here an electric pump is measuring gas passing to the motor mounted at right

Borers at work on three typical ears of field corn from an infested area, where seventeen percent of the grain was destroyed

A few of the three hundred and eleven borers found in a single hill of corn. Destruction of the husks and stubble helps curb the advance of the pests

An ear showing [illegible] by borers. First young tassels are attacked, then the stalk and the grain when it develops

$10,000,000 War on Worms

Fire and Plows Used in National Campaign against Corn Borers That Devastate Fields

This field was devastated by borers, which worked up and down in the stalks making them break before the young sweet corn could mature. The area infested by these worms increased fifty percent last year

FIRES have blazed on 400,000 farms from New York to and through the Middle West, in the last few months, in the campaign to check the alarming advance of European corn borers, the worms that live on corn and that multiplied fifty percent last year.

Congress appropriated $10,000,000 for the campaign in which states cooperated with the U. S. Department of Agriculture. Railroads provided special trains to traverse devastated regions and those not yet reached by the pests, carrying experts who explained methods of destroying and warding off the borers. Quarantines against corn from infested areas were enforced by guards who halted autos suspected of carrying contraband.

Stubble and all else that remains of corn on which borers are found must be burned or plowed under.

The millions spent to eradicate the borers are trifling compared with the millions saved, for the pests, if unchecked, would have destroyed in a few years the whole corn-growing industry.

A hill of sweet corn with the stalks cut to show the work of the borers inside. In this field the borers averaged thirty-seven to the plant. The stalks were so eaten away that they were mere shells, and no ears grew

A ruined field being plowed to destroy borers. The worms cannot live underground and when all the corn is turned under they abandon it and go to the surface. There they starve, or are devoured by birds or insects

Burning stubble and corn remnants of a field ruined by the destructive corn borers. The apparatus includes fuel-pressure tank, pump and "burning carriage" with nozzles that develop heat of 1400 degrees F.

Airships 2,000 Years Old!

Steam engines, motion pictures, and many other "modern" inventions were used by ancient priests to mystify

By H. C. NORTH

Illustrated by Leo J. Richards

How the doors of ancient Greek temples were opened, as if by the gods when the priest kindled a fire on the altar

STEAM, electricity, motion pictures, airplanes, gunpowder—those are inventions and discoveries which characterize modern civilization. They come to mind whenever present-day progress is mentioned, they make our age. But do you know that the ancients stumbled on many of our recent mechanical and engineering discoveries—the steam engine, for example—centuries before Christ?

You probably do not, for very few of the inventions of antiquity survived their day or saw useful application. But the recent appropriation of $100,000 yearly by the Italian Government, to cover the expense of excavations in the ancient Roman city of Herculaneum, has focused attention on the scientific discoveries of two thousand years ago. Concealed in the lava from Vesuvius since the first century of our era, Herculaneum—one acre of which is now uncovered—is every day revealing more than archeologists ever before have known of ancient life and knowledge.

The inventions which today run our factories, light our offices, carry our mail, and add to our comfort were employed first to perform feats of magic to make people believe the priests in heathen temples had mysterious and supernatural powers. They were painfully worked out to deceive and trick the ignorant, and being the trade secrets of the temples, were not common property. In their search for tricks, these ancient priests blundered upon the principles of practically every branch of modern science. Those principles were carefully guarded secrets, concealed in mystery and presented as miracles.

THAT medieval prophet of science, Roger Bacon, in the early part of the thirteenth century, predicted many of our modern inventions, such as steamboats, automobiles, airplanes, diving suits, and so on. All of these, he asserted, were known to the ancients. "These devices," he said, "were made in antiquity, and they are certain. I am acquainted with them explicitly."

Steam was used in the temples of Babylonia, that strip of country north of what is now Arabia, as early as the eighteenth century before Christ. Here, amid mystic rites, images of gods were caused to nod their heads, lift their arms, or open their eyes. Invariably, beneath the altar before the idols, a metal box or tank was concealed. Pipes ran from the tank to a mechanism within the image. Before the supposed miracle was to be staged, hot water was poured into the tank and live coals placed on the altar. A slight pressure of steam was thus generated. It took but the added heat of incense and scented wood to force steam through the pipes and set in motion the crude machinery which animated the idol.

Busterich, who received the homage of the Teutons in barbaric Germany, was a famous idol whose mighty spirit was none other than steam. He was constructed of metal, with a hollow head, and his eyes and mouth were made of wooden plugs. Hot coals placed on his head heated the water within, and the steam thus generated pushed out the plugs and spurted from the apertures.

Hero of Alexandria, Greek writer and geometer of the first century, A.D., described one of the earliest steam engines. He also told of the employment of steam to cause statues to pour libations and serpents to hiss.

The Greek "flying chariot" of more than twenty centuries ago. Suspended from a gas bag, which was said to contain a "minor god," it was propelled by huge wings flapped by a hand crank

HERO further described the use of hydraulics and pneumatics in the Greek temples. Mechanical birds sang when air was driven through pipes by the pressure of flowing water. Temple doors were opened, as if by the gods, whenever a fire was kindled in the altar. This was done by means of an air chamber within the altar, from which a pipe led through the floor to a spherical vessel containing water. The altar fire expanded the air, forcing some of the water from the vessel into a bucket which was hung from pulley ropes in such a way that its descent rotated a pair of posts on which the temple doors were fixed. When the fire was extinguished the process was reversed and a counterweight closed the doors. The syphon, which today conducts water over mountains, caused bronze birds and animals to drink wine. Magic drinking horns and inexhaustible jars, fed by a syphon from a tank concealed in another room, impressed the laity by always remain-

ing filled regardless of the quantity of wine drawn off

One invention of the priests which did not die with its inventors but has passed directly down to us, and is still used by magicians on the modern stage, is the concave mirror. From it sprang the magic lantern and lately its lineal descendant, the motion picture.

DAMASCIUS, the philosopher of Damascus who taught in Athens during the sixth century, A. D., describes an apparition in a temple of Alexandria, Egypt. It first appeared on the wall above the altar as a small light. Then the light grew larger and brighter until it "resolved itself into a face, divine and supernatural, severe but gentle and beautiful." This illusion was effected by placing before a concave mirror, concealed in a darkened room, a brightly illuminated painting or sculpture of a face. The image of the face was thus projected upon the wall of the temple. You have probably noticed this same illusion in your own home, when sitting in a dimly lighted room with the shades drawn. The sun is shining brightly outside, and figures passing on the street are projected upon the ceiling through a small crack beneath one of the shades.

Still more startling was the illusion when pictures of the gods were projected upon smoke from the altar fires, the smoke acting as the screen does for the motion picture. To the superstitious, the apparitions were spirits conjured out of thin air. Huge silver mirrors, perfect in detail, were used by the magicians. And as they grew more adept in the art, living images were cast upon the smoke. Assistants dressed as gods and demons were substituted for the paintings originally used; here, however, two mirrors were found necessary to counteract inversion. When the trick is performed by experts, the aerial figures are uncanny even to those familiar with the operation.

The secret of air navigation was known to several ancient sorcerers. But it was too great a feat of conjury to be divulged even to confederates; so the mystic formula was lost and several times rediscovered before modern times.

THE Greek experimenter, Archytas, who also constructed many hydraulic mysteries, invented in 400 B.C. a dove that could fly. But once it had alighted it could not take flight again until set in motion by its master. Of that wonderful bird, a Latin commentator of the second century, A.D., Aulus Gellius, wrote that it was "suspended by balancing and animated by a spirit." Gellius, however, explained that its motion was due to machinery concealed in the body. We now know that the bird was "suspended" after the manner of the airplane and that the "spirit" which set it in motion was compressed air escaping from a valve.

One of the earliest flying machines was the eagle, formed by Johann Muller, fifteenth century German astronomer which greeted Emperor Maximilian by flying three times around him. An iron fly, built by the same inventor, could soar in a wide arc and return to his hand.

Lighter-than-air machines contributed to the miracles of the Greek priests as far back as 500 B.C. A statue of Apollo, carried in religious festivals, raised itself into the air, then descended into the arms of the magicians. The statue was hollow and filled with natural gas volatile enough to raise and float the image for a moment.

But far more wonderful was the flying chariot which could be guided through the air by a magician who rode in it. As described by an early historian, the chariot was "carried through space by one of the minor gods imprisoned in a bag above." The minor god, of course, was a gas with which the bag was filled. The chariot suspended from this bag was driven forward by huge artificial wings which were operated by machinery. The passenger furnished the power by turning a crank inside the chariot.

The lashing of a sword to the mast of a vessel as a protection against lightning can be traced in the superstitions of all countries. Though it was regarded purely as a superstition, and was forbidden as such in medieval times, it was really the forerunner of the lightning rod of Ben Franklin.

Numa, generally considered a magician by the Romans of 400 B.C., carried on electrical experiments under the guise of summoning Jupiter from the clouds. A pupil, Tullus Hostilius, was killed by lightning while repeating his experiments, or "sacrifices," as they were called. By placing swords upright on the temples of Juno, Numa was able to attract the lightning and cause it to crackle within the temples. The lightning rod for ships came as a result of his studies, but like all ancient miracle workers, Numa pretended that it was an offering to appease Jupiter.

That the early priests employed magnets in their wizardry we know by the statues of the Greek goddess, Diana, and the Egyptian Serapis, which were elevated to the tops of temples and suspended there by magnetic force. The stone images had metal rings in their hair so that the magnets in the temple roofs would attract them.

IT IS well known that the Chinese had invented gunpowder centuries before the foundation of their empire in 300 B.C. It was used by their magicians for rockets and bombs in religious festivals prior to its use in combat. Even among the Christians it was looked upon with superstition, for Constantine, the first Christian Roman emperor, was supposed to have received its secret, in the third century, A.D., from an angel. The formula was disguised in mystic writing until it was finally lost. As late as the thirteenth century, Roger Bacon concealed a formula for black powder in his directions for making the "philosophers' egg."

The wheels, cogs, shafts, and pistons which run our factories, first invented to deceive, were anticipated in the machinery which animated the automata or mechanical images of the ancients. Among the earliest were the prehistoric statues created by the Greek sculptor, Daedalus, which walked and moved. The Greek philosopher, Aristotle (384–322 B.C.), said that they were animated by putting mercury in them, but we know that they were controlled by wheels and weights similar to our modern clockwork.

The ancestor of magic lanterns and motion pictures. Egyptian priests cast a picture of a god upon smoke from the altar fires. To the dark room behind the curtain which projected the image

BECAUSE of a craze for these toys, which persisted until the eighteenth century, when it reached its height, the ingenuity of the ancient mechanic-magician was preserved. Albertus Magnus, Robert Grosseteste, and Roger Bacon, in the thirteenth century, made images that walked and spoke, as well as moving, speaking heads. Then followed the bleating sheep and barking dog of Le Droz; the singing bird of Maillardet; the walking duck of Vaucanson, which ate and digested its food; and the talking machine of Kratzenstein, which could pronounce simple words when air was forced through its various shaped pipes. These and hundreds of others contributed to the science of mechanics and of sound.

Other devices (Continued on page 135)

Max Valier, astronomer-aviator and the trans-Atlantic passenger rocket he proposes

To Europe *by* Rocket

Airship Shot through Sky Could Reach Paris in Ninety Minutes, Says Designer

NEW YORK to Paris in an hour and a half! With rockets instead of propellers to drive it, an amazing airplane proposed by Max Valier, German aviator and astronomer, could, he says, whiz across the Atlantic Ocean loaded with passengers and cargo in this incredibly swift time. A rocket ship, which, he asserts, is capable of climbing to the thin air fifty miles above the sea and roaring through it at more than a mile a second, has been designed by Valier.

To cross the ocean, according to the inventor, you would climb into the cigar-shaped central cabin that houses passengers, cargo, and the machinery that steers and controls the strange craft. All is ready; the pilot jerks a lever. With a tremendous roar the rocket airplane races up an almost vertical runway, flings itself free, and heads straight into the upper air. At an altitude of fifty miles the pilot flattens his course, now he can put on full speed without any danger of burning up the craft like a meteor, for there is little air resistance here. Hardly more than an hour after leaving New York you are over Paris; the craft slows, and descends, and auxiliary rocket motors bring it gently to the earth. Perhaps one stop was made en route for fuel, say at Vigo, on the coast of Spain.

This is possible, Valier says, with a finned ship that carries on its sides huge rocket tubes for propulsion. Besides passengers, it would hold three times its own weight of fuel. Gunpowder, ordinarily used in skyrockets, would be much too heavy. But recent progress has been made in laboratory experiments with rockets using fluid propellant and a new ignition system. Liquefied hydrogen and oxygen under great pressure would furnish sufficient speed by their explosive combustion, according to the inventor. New fuels may prove better still.

Controls would enable the pilot to shut off or to turn on the rockets at will, in order to maneuver his craft. A gyroscopic indicator like those now used in airplanes would guide his flight above the clouds. There would be a "gas lever" to control the speed of the super-airship.

In carrying out his design, Valier says he will avoid risking anyone's life in a full-sized machine. Careful tests must be made before we can tell how to control such a craft. The first experiments will be made with a seven- to ten-foot model. Then several of the "rocket tubes" developed in this way will be placed on the wings of an ordinary airplane to see how the rocket works in flight. If this proves successful, the rocket ship will then be built.

It might prove capable of leaving the earth altogether, says Valier, like other exploring rockets proposed by various inventors. If a speed of eight miles a second were attained, the craft could escape from the earth's gravity and journey to the moon or through interstellar space. But here arises new danger—could human beings live away from gravity?

Even in an earth flight the ship would have to be maneuvered with great care in starting and turning, lest its terrific speed prove fatal to the occupants. During recent airplane races, in which new speed records were made, pilots became momentarily unconscious at the turns of the course. But gradual control of a rocket ship within the limits of human endurance is technically possible, Valier believes.

Fingerprint Records on Skin

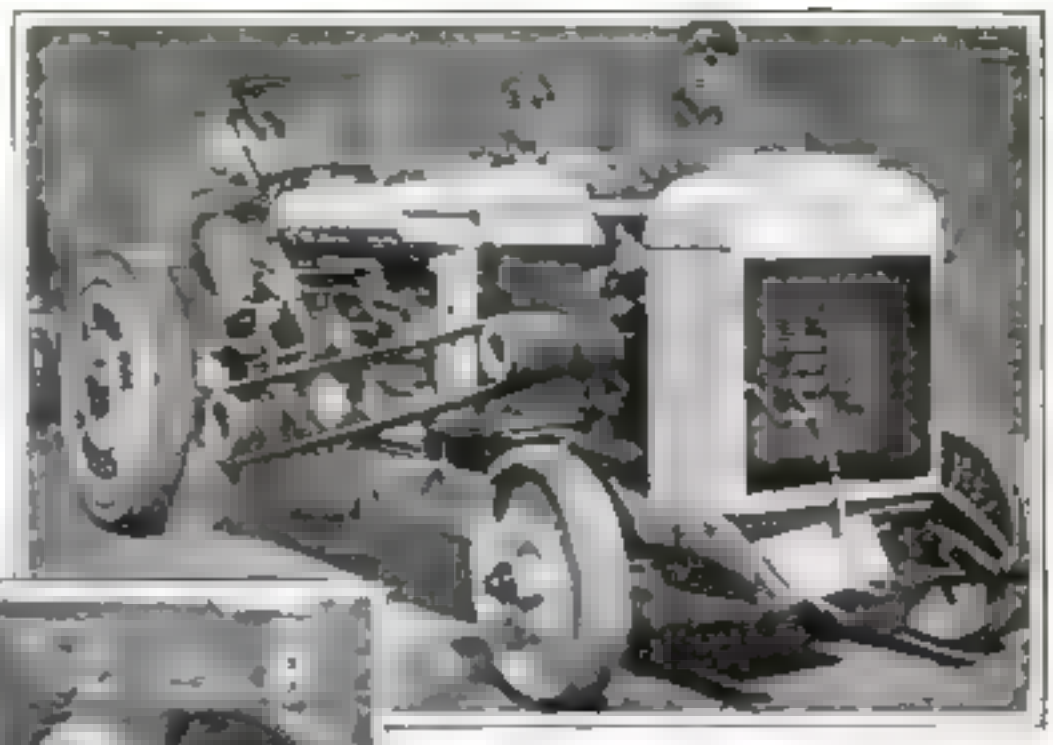
WHILE treating a patient with a certain solution and ultra-violet rays, Dr. Maurice A. Aaronson, of Long Branch, N. J., was startled recently to see brown fingerprints appear all over the patient's back. They were his own. Investigation showed he had accidentally found a new process for discovering and making as permanent as desired, fingerprints on a human body—a "find" which is said to be of importance in criminology.

The method consists of brushing the suspected flesh with a solution whose composition is kept secret, and exposing the body to the ultra-violet rays from a small portable machine. The resulting brown prints are not removed by rubbing, and can only be scrubbed off

Machine Fights Forest Fires

ONCE a battle against overwhelming odds, the fighting of forest fires has now become a science. Forestry officials from Washington and San Francisco recently saw demonstrated at Barley Flats, near Mt. Wilson, Calif., the latest aid to fire-fighters—an amazing tractor-plow that cuts away a swath of brush straight across the path of the fire to serve as a barrier. When the pillar of smoke and flame that presages a forest fire appears in the distance, this marvelous engine on its "caterpillar" tread is rushed through the woods and fields, shearing off and uprooting everything in its way. If the oncoming fire is small, this path alone will stop it; while if it is of giant proportions, the forest rangers use the clearing as a boundary to start a "backfire" that burns away the brush in the path of the threatening blaze

Tractor drags sharp-edged triangular plow, clearing path to bar flames where previous methods failed



Shop in use at right prepared for rush to factory to save delay and expense by welding machine part without dismantling

Welder, having reached scene at speed of five miles an hour, generates power and repairs break "while you wait"

Poison Ivy Antidote Found

AT LAST a cure for the irritation caused by poison ivy, familiar toxic weed of the East, has been found. Dr. James B. McNair, of the University of Chicago, reports that after years of work he has distilled and isolated the ivy's poison, a gummy brown substance in the leaves, and discovered an antidote for it

Ferric chloride solution, a well-known salt of iron, effects the cure, Dr. McNair says. A five percent solution in half-and half alcohol and water, or glycerine and water, is the mixture used, the materials are obtainable from any drug store, and are cheap. When the skin is rubbed with this solution either before going into a place where poison ivy grows or after exposure to it, poisoning never develops, tests have shown. Instead of ferric chloride, ferrous sulphate, another iron salt, can be used with equal success, in a strong solution whose exact strength does not matter

Another effective remedy suggested by J. F. Clough, chemist of the U. S. Department of Agriculture, is a permanganate of potash solution to treat the poisoned skin. It brings immediate relief, he says.

DO YOU LOSE weight when you perspire? Yes, say Dr. Francis G. Benedict and Cornelia G. Benedict of the Carnegie Institution of Washington. With the moisture exhaled in breathing, the weight lost hourly is one ounce for the average woman, a third more for a man. They used balances able to hold a man's weight, one 100 times more sensitive than the other.

A Welding Shop on Wheels

TWO mechanics of Dayton, O., have devised a machine that travels to the job and generates its own current for electrical welding

A welder is mounted on a reboot tractor, the wheelbase lengthened by lowering the gears on the rear axle and reducing friction. The tractor has a side crank and operates the generator by a belt hook-up. Under the generator, which produces an ample current of 300 amperes, is a resistance coil which tends to stabilize the arc.

The possibilities are almost unlimited. The shop may be rushed to a factory to repair a heavy machine part, saving delay and expense of dismantling.

Wheel Operates Car Lights

WITH both hands on the steering wheel, a driver may now dim his lights or sound his horn. In a new French invention, a second wheel that operates the warning signal and makes all headlight changes, is set just inside the usual one. It may be reached easily with the thumbs while control of the steering apparatus is retained. The new arrangement, it is said, makes driving safer

Thousands of Tons of Color

THIRTY thousand tons of color is the present yearly production of dyestuffs in this country, according to a recent estimate. But this is only about half the capacity of our plants. France and Switzerland produce about seventy percent of their plant's capacity.

"Armor" of Germ Analyzed and Found Made of Wax

NOW the germ that causes tuberculosis has been chemically analyzed, and a new phosphorus-containing fat has been discovered that has remarkable physical properties. Recently Prof. R. J. Anderson of Yale University took eight pounds of the deadly bacilli into his chemical laboratory and performed a careful analysis to find what they were made of. These germs possess a waxy shell which gives them unique powers of resistance against the germ-destroying corpuscles of the blood. Prof. Anderson removed it with alcohol and ether, obtaining a pound of wax, a half pound of fat, and a half pound of a unique fatlike substance containing phosphorus, to which he gave the name "phosphosuperide."

"This compound differs from all other known phosphorized fats," Prof. Anderson stated. While he is endeavoring to find its formula, investigators at the Rockefeller Institute for Medical Research, in New York City, are testing the remarkable substance to find a possible clue to a new treatment for tuberculosis.

Another great step against the disease may be taken if a way can be devised to destroy the waxy armor of the tuberculosis organisms, which has enabled them to defy the phagocytes that "police" the body. Instead of being destroyed by these "biological patrolmen" the bacilli have survived and multiplied among them to continue their deadly work.

A Motorist's Rocking-Chair

ALMOST a rocking-chair, with all its comfort, is said to be an automobile seat equipped with a new set of springs to fit beneath it. According to the maker, the oil tempered springs absorb jolts and jars incidental to motoring and make long drives a pleasure instead of an endurance test. Any tilting seat of the type used generally in closed cars may have the shock absorbers attached; two suffice for most persons, and three for heavyweights.

POPULAR SCIENCE MONTHLY is glad to supply, when possible, the names and addresses of the makers of apparatus and devices described in these pages. Inquiries should be addressed to Information Dept., POPULAR SCIENCE MONTHLY, 250 Fourth Ave., New York City.

Through the front windows these elevated rear deck passengers see as well as the riders in the front row

Interior of novel bus for sight seeing has showing five tiers steps and balcony to which they lead

Personalities Made Over

YOUR personality did not develop until late childhood, and even now it is subject to change, according to Dr Charles Judd, of the University of Chicago. Differing with other modern psychologists, who believe that a man's character becomes definitely established in the first five or ten years of his life Dr. Judd declares that human nature is never wholly fixed. The school years are most important in shaping character, he says. Social "instincts" and "taste" are acquired only after a long train of highly complicated experiences, but at any time, he states, it is possible for a grown person, under proper discipline and training, entirely to make over his character.

Super-Beacon for Chicago

MORE powerful even than the airplane beacons of London and Paris is to be a search light at Chicago to guide night pilots New York and Chicago bound. This is the most spectacular feature of a landing place recently planned for Grant Park, a few minutes' ride from Chicago's business center, which will facilitate a night air service between the cities. The super-beacon, 500 feet above street level, will be visible at Milwaukee, Wis., eighty miles away. Like the new fog-piercing scarlet light for the guidance of airplanes, recently described in POPULAR SCIENCE MONTHLY, it may employ electric tubes filled with neon gas.

Sight-Seeing Bus Has Balcony

PASSENGERS in back, as well as those in front, have an unobstructed view ahead in a novel sight-seeing bus recently introduced in Germany. The rear half is raised like a theater balcony reached by steps inside the bus, and occupants peer over their fellow passengers' heads through the windows of a "second story" that pierces the roof. For the first time, all occupants of a bus may have a clear view of the picturesque country in the suburbs of Berlin, where the innovation has been placed in operation.

Lights Show Inside of Eye

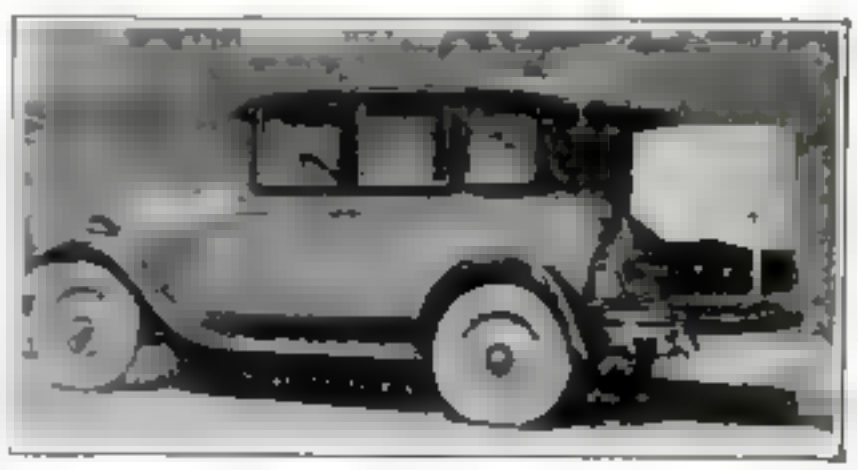
NOW it is possible to look into a living eye through a microscope. This striking feat has been performed by Dr. Basil Graves, of London, England, inventor of a method of lighting that sends powerful beams into the side of the eye. Until the present time it has been impossible to illuminate the eye sufficiently to use a microscope without injury to the organ. A direct beam would play havoc with the sensitive retina which corresponds to the film in a camera; but by sending intense light rays sidewise into the eye, Dr Graves is able to examine it from the front through the powerful lenses of an ordinary microscope.

Baggage Car for Every Motor

A NEW extension for attachment to any motor car, as shown in the picture below, looks like and serves as a trunk when trunk service alone is required, but can be opened and made to carry small trunks, bags, camping equipment or whatnot when occasion requires. The device is of steel and easily carries more than 300 pounds. Salesmen's samples and dairy farmers' milk cans are among the innumerable bulky things whose transportation problems this equipment has solved.

Bees Sip Poison

HONEY that poisons has been discovered in Asia Minor by Dr. K. Krause, German explorer. Eating it causes giddiness and sometimes temporary unconsciousness, he says. Poisonous species of rhododendrons are believed to furnish the nectar the bees turn into toxic honey. This same poisonous honey was described by the Greeks, Xenophon and Aristotle.



Just a trunk ordinarily, this motor car accessory can be opened out to carry small trunks, bags, furniture and so on

World's Largest Dock Can Load an Entire Fleet at Once

WITH completion of the $35,000,000 Gladstone Dock at Liverpool, England claims the largest, and most completely equipped, shipping dock in the world. This monster structure occupies fifty-five acres over the water. It has sixty-six electric cranes to load and unload the numerous vessels which can be moored simultaneously to the huge pier.

Regardless of tides, a unique lock system permits access to vessels of all sizes. The Graving Dock, largest dry dock in Europe, is part of the system. Some idea of the immensity of the docks is given by the men discernible at the waterfront end of the nearer pier in the illustration.

How Much Do You Know of the World You Live In?

TEST yourself with the twelve questions below, selected from hundreds sent in by our readers. For the correct answers turn to page 151.

1. Which is the best harbor in the United States?
2. Where are there blind fish that live in caves?
3. Where are foxes raised for market?
4. What are tortillas?
5. What island is called the "Gate of Treasure?"
6. What is the largest river in the world?
7. What is the Maelstrom?
8. What bird cleans the crocodile's teeth?
9. For what town is muslin named?
10. What is a lama?
11. Where are houses built in trees?
12. Where are small idols put in oyster shells to be covered with pearl?

Builds Diving Motor Boat

MOTOR boat or submarine at will is a remarkable craft designed by Ettore Bugatti, French automobile manufacturer, and now under construction at Moulsheim, Alsace. It can be closed to make a dive, coming up now and then for air; in calm weather it travels on the surface. With this novel craft Bugatti believes that he can cross the Atlantic Ocean from Brest, France, to New York in about fifty hours.

Lateral fins govern the depth at which the craft travels. Six motors, with a total of 2400 horsepower, will give an estimated speed of seventy-five miles an hour. More than a hundred feet long and eight feet wide, it will have a crew of eight.

Earthquake "Made to Order"

WHEN a geologist addresses an audience on earthquakes, he cannot readily arrange a lecture table demonstration as do the chemist and physicist. But Nature came to the aid of James P. Fox, who recently lectured in Los Angeles before the Geological Society of America, on the active rifts or rock faults responsible for local quakes. In the midst of his talk a minor rock-slip occurred, and the meeting was treated to a plainly perceptible temblor.

Expedition to "Lost World"

SOON the "lost world" of Mt. Roraima, Brazil, will yield its secrets to the American Museum of Natural History's expedition, now under way. The high plateau with the sharp-cliffed peak of Mt. Roraima, the scene of Sir Conan Doyle's famous story and movie, "The Lost World,"—is older geologically than most of South America, a promising place to look for prehistoric traces.

The expedition has no hope of finding the dinosaurs and winged pterodactyls of Conan Doyle's romance, but its biologists, T. D. Carter and G. H. H. Tate, believe that they may come upon other animals, possibly descendants of these, unlike any known at the present time.

What the Moon Is Made Of

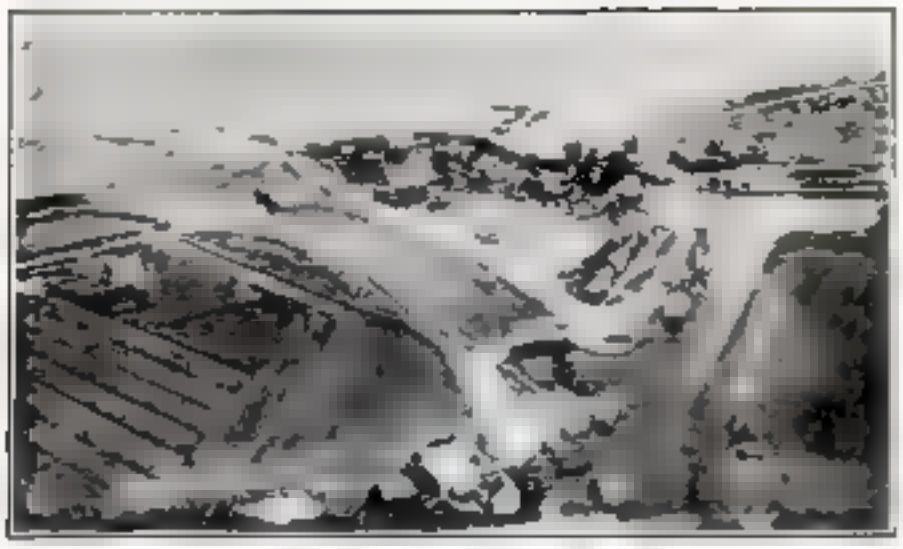
ONE common earth rock is totally absent on the moon, says Dr. F. E. Wright of the Carnegie Institution at Washington, D. C., after a remarkable series of studies of our nearest heavenly neighbor made with polarized light, which differs from ordinary light waves in that its vibrations are on a flat plane.

Basalt is the missing rock, says Dr. Wright. Originally formed by volcanic action, it is abundant on earth. Other rocks detected on the moon are lunar, they include pumice and granite. Both of the latter reflect light in an ordinary way, as does any other rock containing much of the element silicon found in sand and glass. But when a ray falls on basalt, it behaves quite differently. All its vibrations except those in one flat sheaf are "rubbed off" and the light is "polarized." With delicate optical apparatus that could measure this polarization, incomplete at best, Dr. Wright studied the materials that compose the moon's surface.

Hop Growers Work on Stilts

YOU have to be good at walking on stilts to raise hops in Kent, England. In preparing the eighteen-foot poles to carry the trailing hop vines, gardeners make the rounds on lofty stilts, carrying with them a supply of twine. The scheme has worked out splendidly, for it takes a worker only a few minutes to restring the poles with cord to carry the vines, as he goes walking along with giant strides many feet above the ground.

Walking on high stilts, the English gardener above restrings the poles for his hop vines



Airplane view of completed sea wall to island of Wieringen

Dike to Enlarge Holland

WITH the recent completion of a sea wall from the Dutch mainland to the island of Wieringen, engineers have accomplished the first step of a gigantic undertaking that will totally change the map of Holland. They plan to remove the Zuyder Zee—that great arm of the North Sea that swept into the interior of the Netherlands six hundred years ago and has remained there ever since.

A wide expanse of water only ten to twenty feet deep, yet fifteen hundred square miles in area, is now to be blocked off by a huge dike, fifteen miles long. Then the gulf will be drained increasing the country's total land area by more than a tenth. Begun in 1863, the project is now well under way and will probably be completed in ten years.

Vibrating Bed Woos Sleep

SLEEP is easy in a new bed that rocks like a cradle, the invention of Sir Alfred Yarrow, British physicist. Long troubled with insomnia, he found that the rocking motion of a railway train put him to sleep. Under his direction, the National Physical Laboratory in England constructed a bed that reproduced the same motions. They occur at the rate of eighty a minute, and the vibrations are short—only three eighths to three quarters of an inch in range. Lest the movements produce nausea, they are made to occur irregularly

Aviator Chases Rainbow

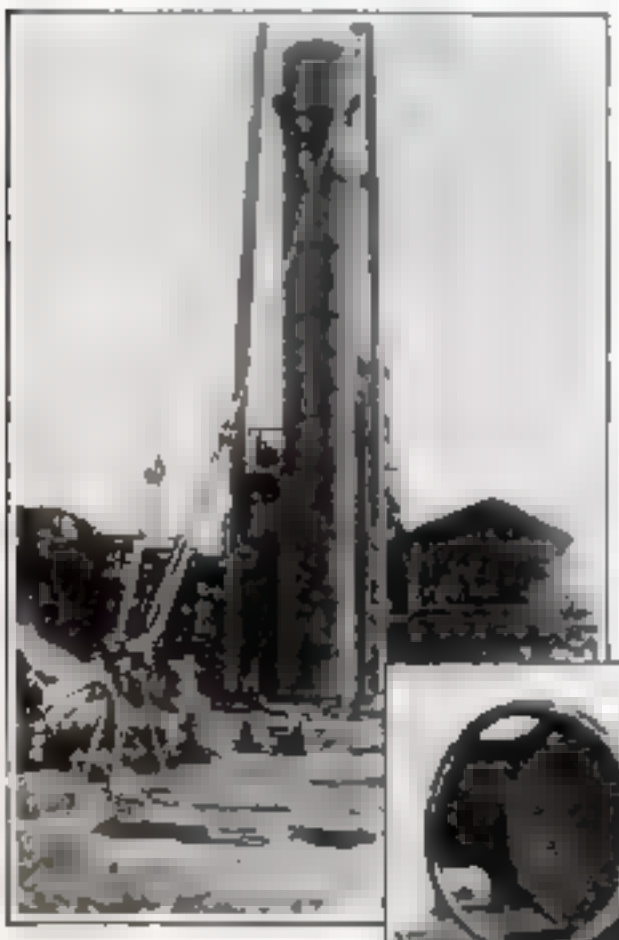
ALTHOUGH many a child has raced after a rainbow to find the legendary pot of gold at its end, it remained for an Army aviator to pursue one in an airplane. Flying east to Washington to participate in the recent air maneuvers, Lieut. P. E. Skanse saw appear below him a magnificent rainbow which formed a complete circle—a rare spectacle reserved for aviators, sailors and mountain climbers. The colorful ring glowed above an Illinois plain, near Chicago.

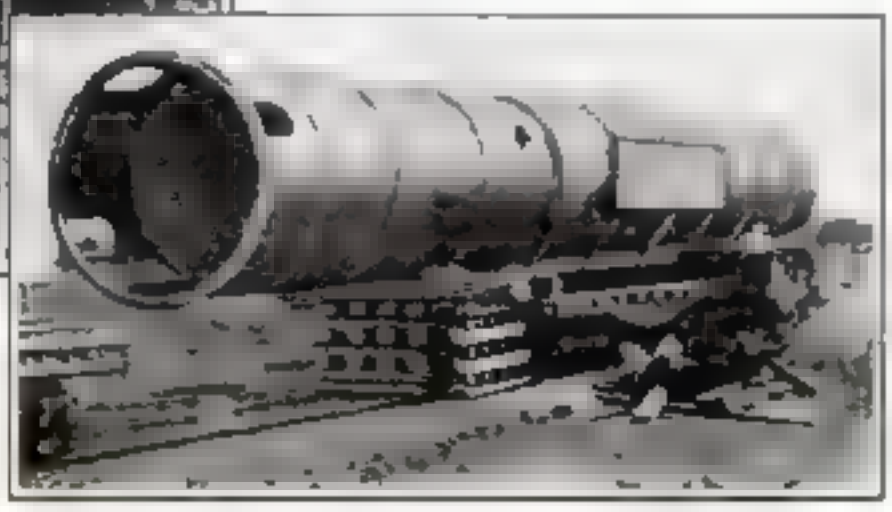
Mask Saves Pugilist's Face

IN ORDER to protect a champion boxer's face from possible damage at the hands of his sparring partners, a curious new type of mask has been invented in Germany. First reported from Berlin, it has already been adopted by several German boxers for their training bouts. The grotesque headgear is attached by straps about the head. Its padded ridges protect the eyes, nose and jaw of the boxer without hindering his breathing, sight, or movements.

World's Biggest Freight "Parcel," 80 Tons

A TOWER used in the manufacture of gasoline recently made the largest piece of freight ever shipped over a railroad. Just delivered at Los Angeles from Boston, the eighty-five-foot tower, weighing nearly eighty tons, was carried on three flat cars. Due to its length and weight, a route was chosen that avoided extreme curves and grades. The consignment was unloaded step by step, as each car was slid from under, blocks were inserted to support the tower. Erection at the refinery required use of two giant tripod poles as legs of a derrick. Eight months of breath-taking effort swung it into place after days of preparations.





Above: Hoisting one-piece tower with reinforced derrick. At right: Unloading the eighty five foot tube from three long flat cars was an engineering feat

Horse's Mummy in Coffin

HORSES as well as human beings were preserved as mummies by the early Egyptians, according to a recent discovery by British officials at Sakkara near Cairo, Egypt. They found a coffin containing a two-year-old Egyptian horse that had been mummified and ceremoniously buried about 4000 years ago. Its hind legs wrapped in cloth and tar-stained up legs were tied together with papyrus ropes.

KNOW YOUR CAR

THE brakes on your motor car depend for their effect on the amount of friction that is developed between the brake lining and the brake drums. And the amount of friction is determined by the condition of the friction surfaces.

Under ideal conditions, the effect produced by the brakes should always be the same for any particular amount of pressure that is applied to the brake pedal. However, those conditions never can be completely obtained, because of varying weather, increasing effects of wear and imperfect adjustment.

Dry and dusty brake lining grips strongly. Wet and slimy lining is not nearly so effective. Rough or badly scored brake drums cause wear on the linings and this throws out the adjustment so that the brake pedal leverage changes.

For best results from your brakes, follow these rules:

1. **Make sure that the brake drums are smooth and that they run true.**
2. **Have the brakes lined with the best lining you can buy.**
3. **See that they are kept properly adjusted.**
4. **Don't expect them to hold as well in rainy weather**
5. **Adjust the brake bands so that they do not touch the drums when your foot is off the pedal.**

A Dozen Products

An unusual clock with a face like a speedometer is the invention of H. M. C[illegible] The figures [illegible] the hours [illegible] on a revolving [illegible]. The clock [illegible]

[illegible]

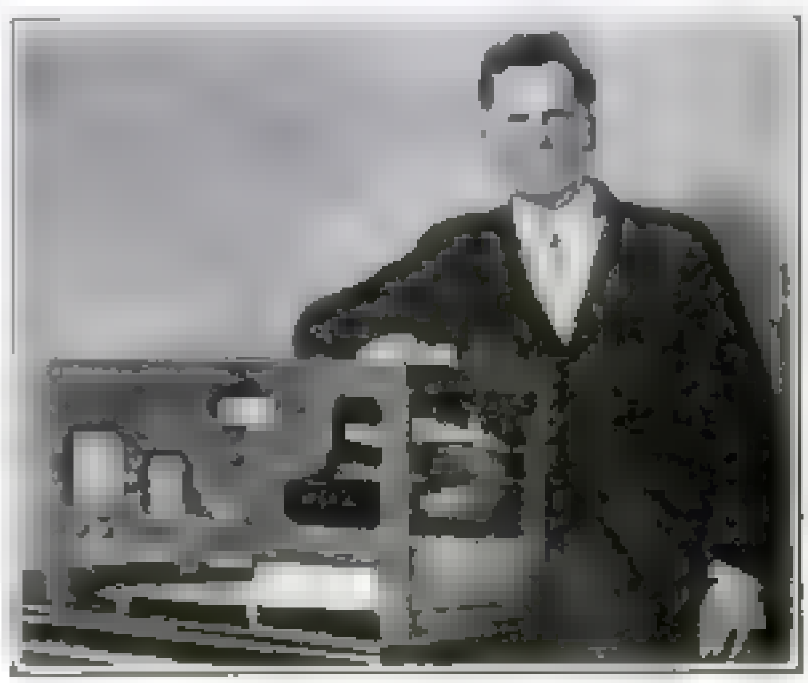
This [illegible] in San A[illegible] [illegible] a Mex[illegible]

The [illegible]

[illegible]

Amateur astronomers can find the North Star with the aid of this ingenious device invented by Clement Engel, of New York City. Two magnetized steel bars, balanced to swing horizontally as they hang on a thread, point north and guide an inclined wooden rod to show the position of the polestar. Within a wooden ring is a small model of the earth shown at correct inclination

As [illegible] at the Alabama [illegible] saw [illegible] and energy [illegible] He [illegible] at the right [illegible] He claims it will fold and feed into envelopes 5000 letters an hour—the task of ten men working at top speed!



of Inventive Skill

Now you can turn your phone into a radio set George F Mitchell, of the U S Department of Agriculture, invented this simple attachment that converts any telephone instrument into a crystal receiver for reception of local broadcasting. Two pins tap the phone wires to serve as antenna and ground. The crystal detector is manipulated by a knob at the top. A bracket holds down the receiver hook

Fillings of precious gold that the dentist loses are saved by the new attachment, shown above designed for use with the ordinary equipment for grinding down inlay and bridge. It catches the costly bits in a hood. The inventor claims it saves ninety percent of the filings. The loss to be overcome is illustrated by the U S Mint's recent extraction of $200 worth of gold from a dentist's rug

Here's an easy way to fertilize your garden. An attachment inserted at the faucet contains a "stick" of soluble plant food which is dissolved automatically into the hose stream. Thus the plants are sprayed with a mixture of fertilizer and water

Paddling his paper canoe Willy Behauer German inventor is shown above The paper is stout, hard and waterproofed. Advocates of such boats say they are lighter than wooden ones, yet equal them in strength and hence in safety They also contend the cost of manufacture is lower The builder says his craft has met all the tests to which wooden or canvas canoes are subjected

"Scarlet fingers of light," 100 feet long, as night signals for English traffic police are advocated by J W Blakey, English inventor, shown at left with a new lamp he has devised to project a rocketlike ray Motorists can see the signal from afar he says, avoiding traffic tangles

The motor-driven "seasick chair" shown above reproduces the roll and pitch of a ship and is used by French officials to test applicants for navy and merchant marine posts. If they endure this ride, they fear no ocean, for it rivals the roughest sea

A Skyscraper of Glass

A SKYSCRAPER modeled in glass, recently exhibited in New York, shows in a striking way how art and utility will be blended in the giant buildings of the future if those who propose them are true prophets. Masses rising to a dizzy height in vertical lines and elongated towers are features of the proposed new type of architecture. Designed by Hugh Ferriss, noted architect, the ingenious glass model shows more clearly than any set of blueprints both the outside and inside of a new style of skyscraper, that will be supported by steel girders in a circular well at the center. Office suites surround the "hub" in radiating fins.

Squirrel's Memory Tested

CAN squirrels remember where they hide nuts? L. R. Dice, of the University of Michigan, says they can, after testing the nut finding ability of a fox squirrel that came regularly to his house to be fed. By placing some nuts buried and others uncovered in a box of sand, he found the squirrel discovered only the nuts that were in plain sight. If all were buried, the squirrel would depart without dinner.

This, he says, shows that squirrels do not "smell out" buried nuts, as many persons have thought. "If squirrels do not find buried nuts by use of the sense of smell," Dice declares, "the presumption would be that they remember the place where they have buried each nut that they find. This would require a well developed memory, though not necessarily a perfect memory, for squirrels undoubtedly fail to find many nuts they have buried." His observations confirm the recent similar conclusions of Dr. A. Brookes Klugh, of Cornell University, who has studied red squirrels for eight years, and has watched individual squirrels for as long as two years.

Biggest Family, 44 Children?

NEW interest in the disputed question as to who has the largest family has followed the recent discrediting of the report that a German named Schenberg is the father of eighty-seven children by two marriages.

Biologists are still uncertain as to the maximum size of a human family. According to Robert Cook, editor of a medical publication in Washington, D. C., the most authentic case of a large family is that of Dr. Mary Austin, a Civil War nurse, who had claim to a family of forty-four children—thirteen sets of twins and six of triplets. While bringing up her family she found time to study medicine and obtain a doctor's degree.

Seeds Forecast Tree Sizes

THE bigger the seed, the better the tree, is the conclusion drawn from recent tests by the U. S. Forest Service. When seeds of such important western forest trees as the California sugar pine, western yellow pine, and Douglas fir were planted under careful supervision, says E. N. Munns, chief of the office of forest experiment stations, large seeds were found to produce uniformly large seedlings. Transplanting, the tests also showed, nullifies this advantage; for the larger roots of the overuse seedlings are more easily damaged when dug up.

Medal for Purest Insulin

FOR his recent discovery of a way to prepare crystalline insulin of hitherto unknown purity, for treatment of diabetes, and for being the first to prepare the gland extract adrenalin in a form available for treating the blood vessels, Dr. John J. Abel, noted biochemist of Johns Hopkins University, has been voted the man now living who has done most to promote enjoyment of life. The Willard Gibbs Medal, awarded yearly for this service, was presented to him at a recent meeting of the American Chemical Society. "The human body is a walking drug shop," Dr. Abel told the society. "There are, perhaps, seventeen glands in the body which secrete and pass into the body certain substances. We are just beginning to understand a little about these glands and their functions."

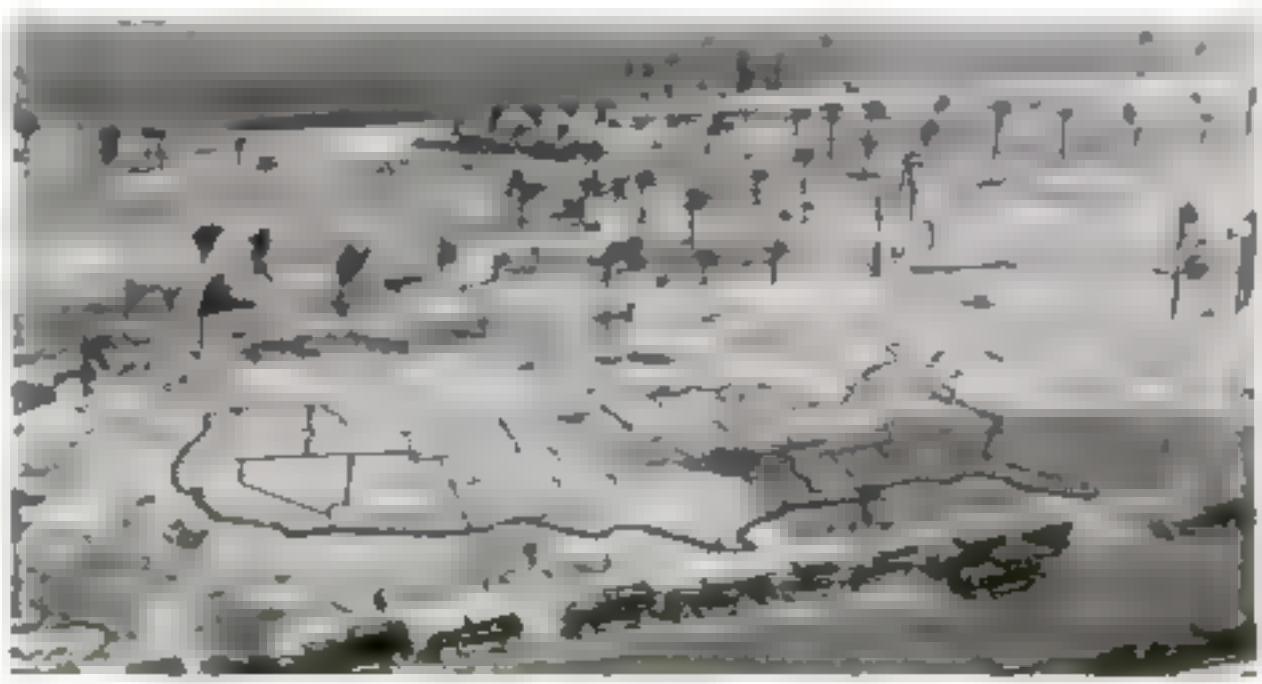
Dropper Feeds Tiny Birds

YOU couldn't find a much smaller pet than a baby hummingbird. Two of them, "Gay Boy" and his sister "Bee," were recently adopted by Jimmie Mitchell, of Los Angeles, Calif., when he found them lying on the ground, their nest knocked down by a dog. They are thriving on a daily diet of honey and water, fed through a medicine dropper by their twelve-year-old keeper, and soon will be strong enough to fly.

The illustration above shows Jimmy giving "Gay Boy" his lunch. This bird, the liveliest, soon began trying his wings every morning, while "Bee" sat on a large pink rose and watched the fellow orphan with keen interest, as if studying for future efforts along the same line.

Garden Is Floral U. S. Map

FLOWER gardens of many shapes have been seen, but so far as known the one shown below is the first of its size patterned on a map of the United States. Forty-eight states will appear in blooming colors at Bay Front Park, Miami, Fla. Made of flowers and shrubs contributed by cities in the various states, the unique floral map will be maintained perpetually by Miami's municipal park division.



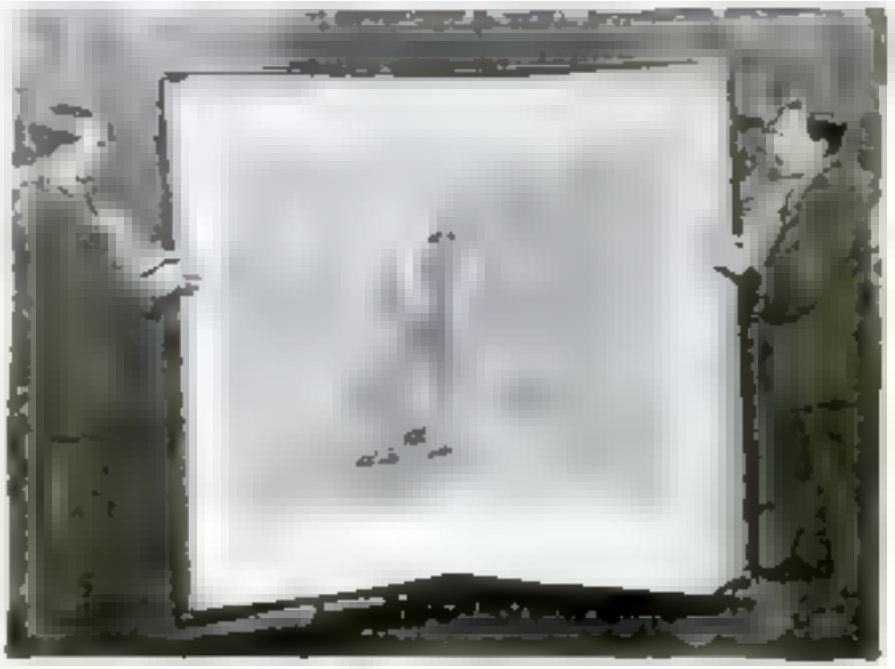
Forty-eight states contributed plants for this United States map produced in blossoms in Bay Front Park, Miami, Fla. Miami girls, former residents of the various states, planted the flowers

Magnifier in Pencil Style

ALWAYS handy and easy to use is a powerful new magnifier in a pencil-like barrel, with a clip for carrying in the pocket. Two small lenses in the barrel magnify an object twenty-five times. The enlarged image is seen in the open top of the "pencil," while the lower end is cut away at an angle to permit full illumination of the object examined. Students of natural history in the field, and postage stamp collectors, will find this device useful for [illegible]

World's Largest Book Is Taller than a Man

TALLER than the average man, this gigantic atlas is said to be the largest book in the world. A gift to King Charles II, ruler of England in 1660, from the merchants of Amsterdam, it now occupies an extensive space in the British Museum in London. Latin inscriptions and text appear on the maps, which are surprisingly accurate in view of their age. The gift was a memento of Charles' visit to the Netherlands where he found friendly refuge after the fall of the British monarchy.



Two men of average size shown standing beside the 287 year-old atlas, give an idea, by comparison, of its enormous dimensions

Rat-Proof Ships End Plague

[illegible]

Charts Predict Track Record

STAR reaches out for a world's record, a mile [illegible] That is the struggle faced by Dr. Earle R. Hedrick, [illegible] of the University of California.

After careful examination of the present world's records of various distances, Dr. Hedrick suggests that the record [illegible]

[illegible] Seen in Radio Precision

[illegible]

Magnifier in Pencil Style

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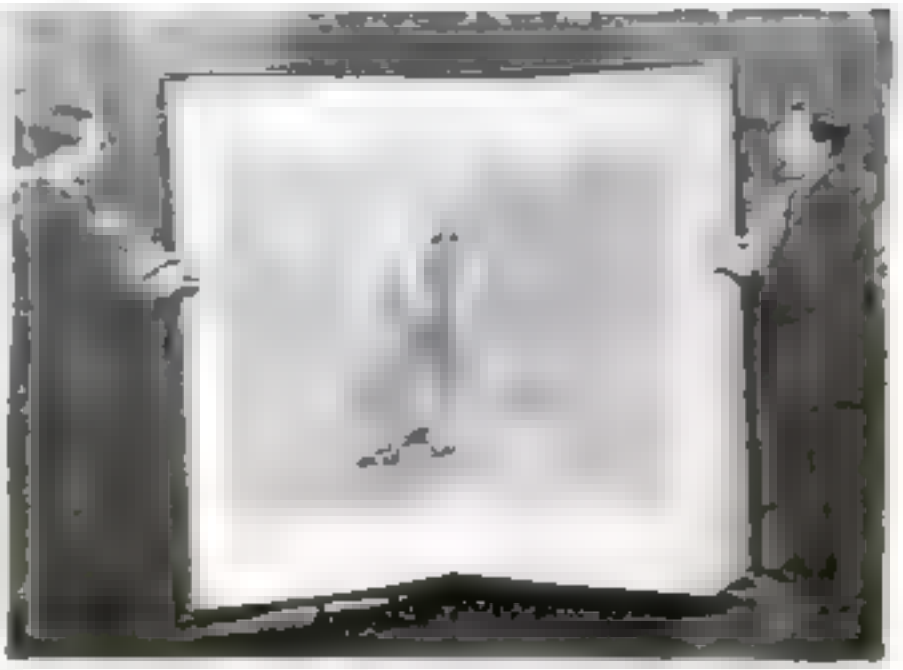


Two men of average size shown standing beside the 287 year-old atlas, give an idea, by comparison, of its enormous dimensions

Rat-Proof Ships End Plague

RATS on shipboard, responsible for stories and traditions that date from the earliest days of navigation, are soon to be eliminated forever, according to

Charts Predict Track Record

STAR runners, out for a world's record, should try the 880-yard run. That is the suggestion of Dr Earle R Hedrick, mathematician, of the University of Cal-

Gain in Radio Reception

Bricks Are Now Tested by Their Ring

CARBON for the brushes of electric motors, and brick for building, tell their secrets to the engineer in two novel processes just developed for detecting faulty materials by their "ring" when struck.

Making a musical instrument out of the carbon brushes, rectangular blocks of the hard black substance that carries electricity to the whirling rotor, is the testing scheme used by Dr G M Little, of the Westinghouse Electric and Manufacturing Company. He has constructed a "xylophone" of several standard-sized carbon blocks, of various quality, that range in pitch from the musical tone G sharp to A sharp, a little higher. Test samples are compared in their pitch when struck with a drumstick with those of the "xylophone," and rejected if they fall below G sharp.

Another device, for testing bricks, does not depend upon the trained human ear. The invention of Juichi Obata, of the University of Tokyo, Japan, it photographs the sound of a brick struck by a hammer so that the exact character of the sound can be studied. The sound is picked up by a microphone, amplified by radio apparatus, and used to operate an oscillograph, or sound recorder.

Almost Beats the Camera

WHEN the winner of the recent motorcycle races at Munich, Germany, flashed past on the last lap, a high-speed camera trained on him barely managed to record the passage. The remarkable photograph below, which gives some impression of the speed at which he was traveling, was the result. In the infinitesimal fraction of a second that the camera's shutter took to expose the plate, the cyclist's flying image had moved halfway across it.

The peculiar distortion which resulted is characteristic of pictures of swift-moving objects at close range made with the "focal plane shutter" used in fast cameras. The shutter, a sliding curtain with a slot in it, "wipes" the picture on the sensitive plate a section at a time.

"Hops Off" from Surf Board

THE remarkable feat of leaping from a surf board behind a fast motorboat to a plane speeding overhead is the recent accomplishment of Mabel Cody, girl "dare-devil" of Tampa, Fla. Throngs of spectators on shore near the Davis Island, Fla., marine speedway, saw her succeed on her 113th attempt after six days of failures. So far as is known, the stunt never has been equaled. The transfer was made by means of a rope ladder dangling from the plane, as the speed photograph below shows. Note the precarious grip she managed to obtain on one side of the rope ladder and the movie camera trained on her as she made her difficult ascent, also the guide rope to keep the ladder from swaying

Prehistoric Monster Lives

RECENT expeditions into the swampy, almost impenetrable fastnesses of southern Java have brought back photographs giving the first authoritative evidence that a monster differing little from those of prehistoric times still survives in the most jungle. It is a one-horned rhinoceros-like creature, its hairless hide covered with small horny scales, says Dr. P. Vageler, German zoologist, who reported the discovery. Enormous front teeth resemble those of a hippopotamus. Natives call it the "tangguing."

Man Races Horse

CHARLES W. HART, the English runner who races against horses in London to prove, as he has done, that human endurance is greater than equine, is shown above in white sunbonnet and running pants, at the start of a recent contest. The race continues six days, twelve hours a day. The horse relays with another while Hart runs alone. He takes his food, most of which is in liquid form, while on the track.

Speed is not attempted in these contests, the only purpose being to test staying power. Dr. Everhart Drake, sportsman-zoologist, is riding Hart's opponent. In a similar contest held a year ago, against two horses, Hart was the winner.

Electric Brakes for Autos

ELECTRICITY may stop your car in the future. A new electric brake system, already manufactured for trucks and trailers, is said to use less current to operate a set of four-wheel brakes than is needed to run one headlight or blow the horn once. All the electricity does is to set in motion a mechanical brake wheel, as then applied by an ingenious device that takes its power from the forward movement of the car itself. It is reported capable of stopping the heaviest machine in a short distance, for the greater the momentum the greater the braking force.

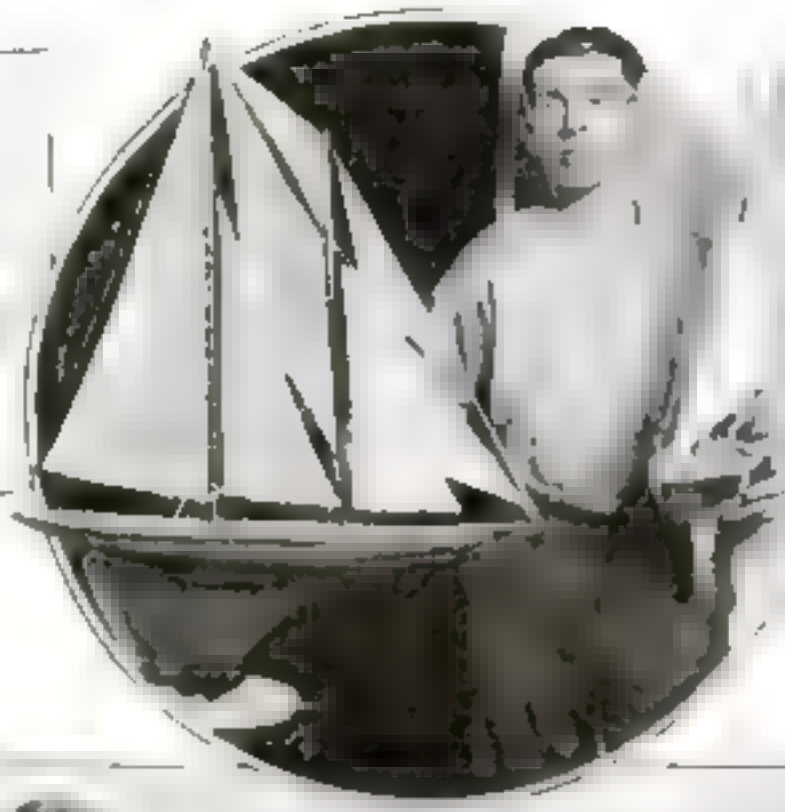
2,000,000-Year-Old Pine Cone

TWO million years ago a pine tree fell before a flow of molten lava in what is now Placer County, Calif. A cone from that tree, preserved by the solidified rock in perfect condition, has just been discovered by a prospector and sent to the department of paleontology at the University of California. Experts vouch for its extreme age, adding the remarkable fact that it is of a species which exists today unchanged through the ages.

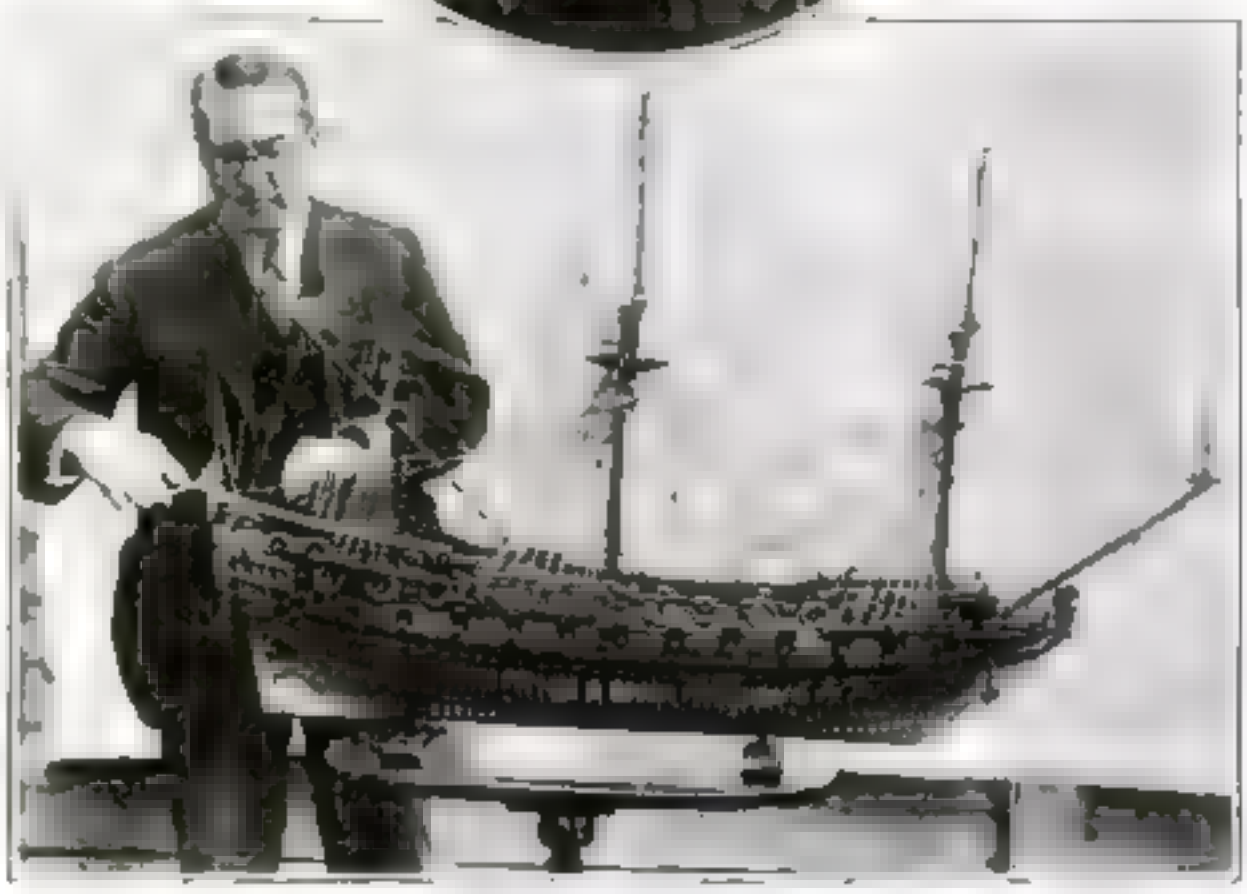
This motorcycle racer at Munich not only defeated his rivals but almost beat the high-speed camera, which in an instantaneous flash could make only this distorted picture of his passage

Ship Models — Young and Old Find Profit and Joy in Building Them

Bob Nixon, a student in the Minnesota State Normal School, puts the finishing touches to his model of the Old Ironsides from Popular Science Monthly's plans



R. L. Redfield, Cinque Ports Manor, with his Spanish Galleon as well from Popular Science Monthly's plans has taken innumerable trophies with it



In the circle above Le Roy D. Thomas and Howard R. Hall show the model of an ancient galley he has been working on. A Parliament sheep. With this and the fine and the eggs roll on a pheasant but the feathers must can be removed changing [illegible] Thus the rule are to [illegible] a piece of [illegible] different shapes. Hall [illegible] model [illegible] and models as a hobby

Henry H. Cleaver, New York lawyer, who as a hobby [illegible] boys his [illegible] care [illegible] and historical knowledge [illegible] ships models [illegible] seen at the left repairing a copy of the Seventeenth Century frigate the *Dare* [illegible] Col. Henry H. Rogers, owner of the model, has [illegible] for thousands of dollars

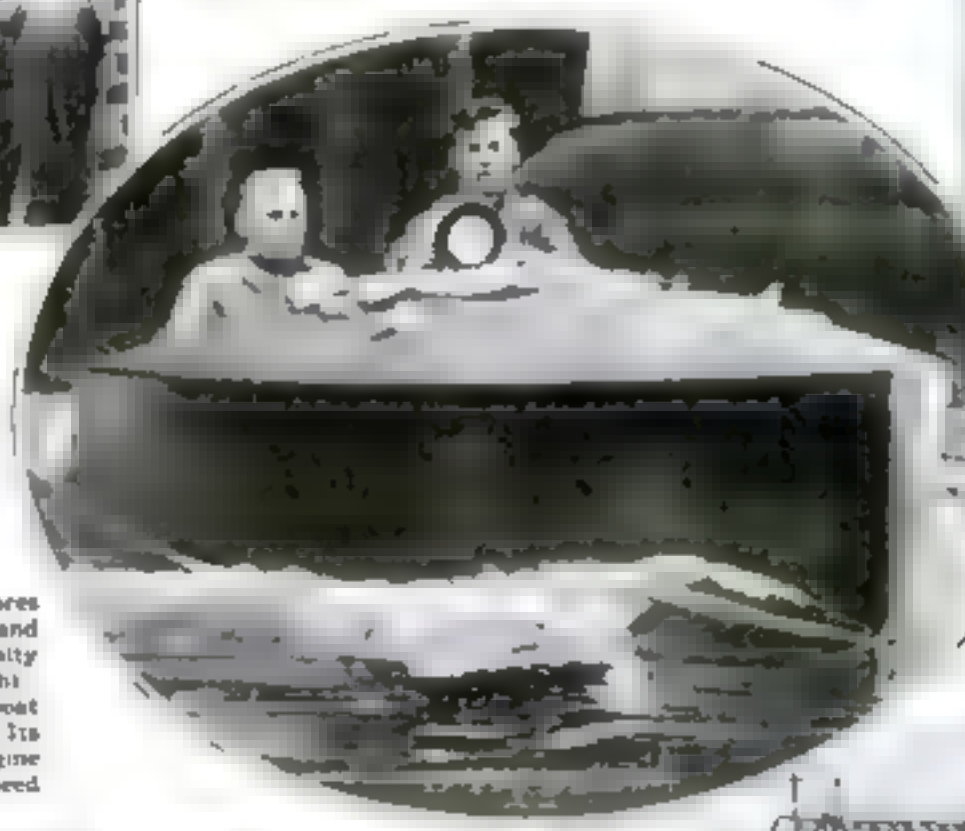
Everyone wanted the models of old ships that Alphonse M. Orcis and Karl Bauer built for fun, so they hired assistants and entered business in New York. This view of their shop shows workmen assembling hulls of model galleons. The ships they make are accurate in every detail

You can't begin to learn ship modeling too young, believes Alex H. Sjoklund, of Manchester-by-the-Sea, Mass. In his unique school, the "Dock Yard," boys and girls learn the fine points. Note particularly the large motor boat model in the foreground, a product of youthful skill

Clever Feats *of* Handicraft

Clyo Puffal, Monona Iowa, farmer, carves elaborate fans and flowers, each from one piece of wood. He uses only three tools

With five thousand pieces of wood, Henry Bieberich, of Fort Wayne, Ind., made this elaborately inlaid clock case



A miniature Ryan monoplane shown by Paul N Edwards, of Denver is builder is driven by a one-eighth horsepower electric motor Shellacked silk covers its aluminum frame The Lindbergh plane Spirit of St Louis was of this type

To view college boat races recently, James Tyson and Theron Howard, University of California students right built their own speed boat in a home workshop. Its powerful hydroplane engine produced surprising speed

With the steering worm from an old motor car attached to the rudder post of his launch, Harland Pancher of The Dalles, Ore finds steering a simpler and less tiresome task Cables connect the shaft and the steering wheel

With front wheel drive, this car will not skid, says Arthur Nichols, Massachusetts Institute of Technology engineering student, who built it of spare parts in 365 hours of spare time. He admits it looks odd but declares its performance equals that of many "store cars"

The carpentry class of Roosevelt High School, Los Angeles, designed and is building on the school grounds the house shown here in course of construction. When finished it will house the domestic science department, and serve as a community center for the school district

Telephone Meter Sells by Word

THE little black meter box atop the telephone illustrated above dispenses telephone service by the word and sentence, charging "a la carte" according to time consumed.

The instrument can be [illegible] over a [illegible] line of Courtesy Bell Inc. of Rochester, N. Y., and Garrison Babcock, of Seattle, Wash. It has been used with remarkable success in Everett, Washington, where telephone rates are said to have been reduced forty percent, while the number of subscribers has doubled since its installation. It also discourages useless talk on the wires.

Two units of time, the "telechrone," equal to one minute of telephone conversation, and the ten designating fifteen seconds of conversation, have been created for the new service. The device is controlled by electricity through a master clock, and is entirely noiseless. The charges are computed monthly from meter readings, made similarly to those for water, light and gas service.

A New X-Ray Discovery

NOW the killing power of X-rays, used on human tissue as a treatment for cancer, has been shown to depend not upon the wave length but on their intensity alone. For a long time scientists were in doubt as to whether long wave X-rays, used for surface skin treatment, had the same curative powers as the penetrating short-wave rays that are employed for deep-lying disorders.

Biologists of the Institute of Cancer Research of Columbia University, New York, recently tested both by exposing female fruit flies to rays of various wave lengths and intensity. Eggs laid by the flies were then tested for fertility, those exposed to the strongest rays did not hatch, while the others did, regardless of the wave lengths of the rays employed.

Live on a Vast Ice Cake

IN AMERICAN climate is too warm [illegible] Northern Siberia, where the earth is frozen the year round to depths of more than a hundred yards. Thus ice ground says Prof. Sebastianoff of Irkutsk, Siberia covers [illegible] square miles equal to half the area of Europe! In Jakutsk a well was sunk 363 feet without reaching unfrozen earth. Directly beneath stove heated homes the ground thaws. Sometimes these thawed columns tap underground rivers beneath the ice layer and [illegible] Artesian wells spurt into the houses.

Open Door Burglar-Proof

A DOOR so locked that it will open a few inches only, admitting air for ventilation but no burglars, is demonstrated above by Charles Brand, its inventor. A bar extending from the frame is locked to the door so that the man outside cannot reach through and unfasten it as he could the old-fashioned chain and slot guard, which once the door was partly open, was ineffective unless someone inside protected it from the would be intruder.

Pipe Sweetened by Steam

FOR cleaning old, ill smelling tobacco pipes, the instrument above has been devised. A teaspoonful of wood alcohol or gasoline, placed in a little cup, heats another little cup which contains water. The steam thus formed enters the pipe through a rubber hose, and after thoroughly penetrating the pipe finally comes out through the bowl.

All the foreign substances loosened through this method it is claimed. After the pipe has been steamed for about five minutes, the operator scrapes out the loose stuff in the bowl, leaving the pipe sweet and clean for smoking.

Lifeboat Inflated Like Tire

A MAN jumped overboard in the harbor at Hamburg, Germany. Twenty minutes later he was being hauled over the side of a collapsible pneumatic lifeboat which had been inflated and launched with surprising speed. It was the first test—reported highly successful—of the *Move*, first of a new type of craft for rescues at sea. Occupying less space than the ordinary lifeboat, and easily transported when not inflated, the vessel in action can hold sixty persons. Besides those who must be taken aboard because of exhaustion or cold, the craft can keep afloat as many stronger ones as can seize the ropes and grips along its sides.

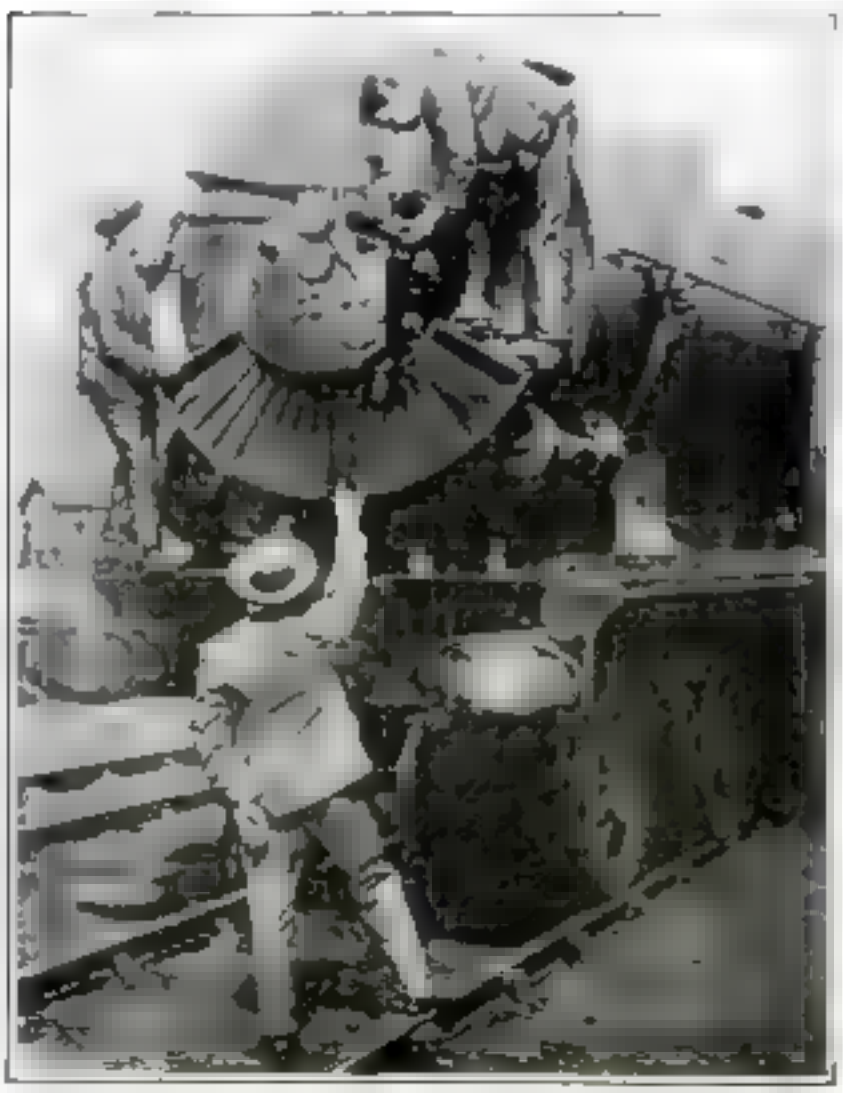
Hauling a rescued man aboard the inflated rubber boat. Notice the ropes and grips along the side, to which victims of a shipwreck at sea, if they are not too exhausted, might cling

Self-Service Hat Checker

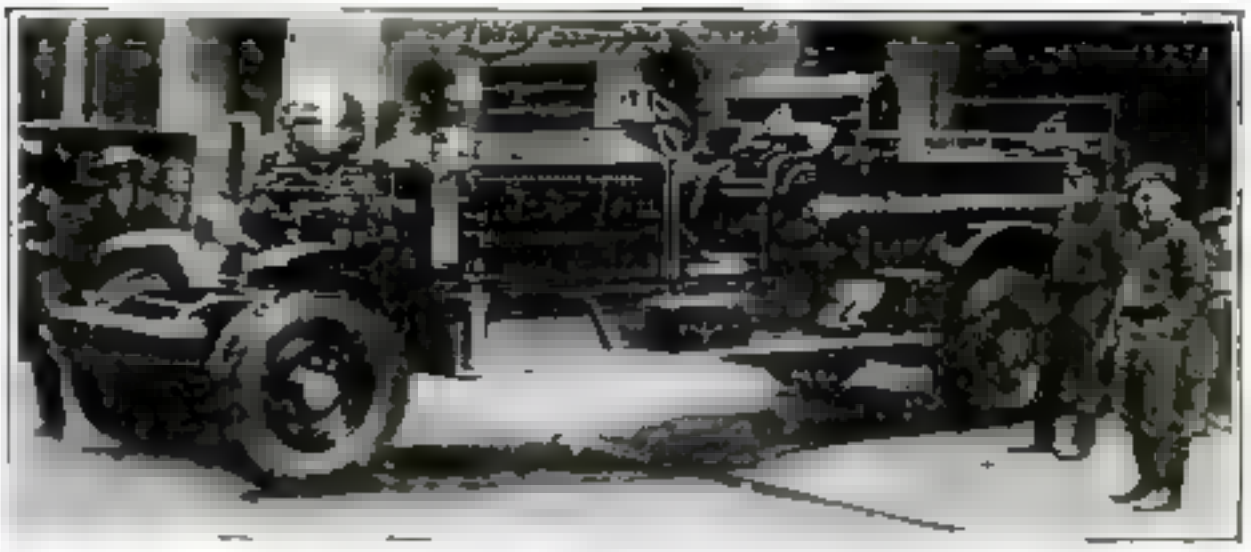
FOR a nickel patrons of a Cincinnati restaurant can check their hats and coats with an ingenious mechanical hat checker. The hat goes over a raised disk mirror in the center; then a hinged ring swings down around the brim, locking it to the coat hanger below. From the coat hanger, a chain runs through the coat sleeve to the lock. With a key and your coin you unlock your property.

Amazing Locomotive Tested

A NEW turbine locomotive that consumes its own smoke and condenses its used steam into water to be used again and again to feed the boiler is undergoing tests in England. The condenser is in the rear. The ventilator, which sends smoke back to be burned, is shown on the front in the photograph below. The smoke consumption not only makes the engine cleaner, but it also furnishes additional heat.



Engineers are adjusting the locomotive's smoke-eating device—a ventilator that carries the smoke back to be reburned



Wakes Up Sleeping Muscles

A NEW exercise device, designed especially for training athletes, is said to develop muscles of legs and back that are not put into play by any other method. It consists of a high chair to which are attached two pedals connected with sliding weights. The exerciser pushes forward with his feet against the pedals. The weights can be varied as desired.

Germs Give Light

THAT certain organisms so small that they cannot be seen through the microscope may play an important part in the amazingly efficient "cold light" of the firefly and other insects and lower animals is the theory advanced by Dr. Umberto Pierantoni, biologist, of Naples, Italy. His experiments, he says, indicate that minute germs introduced into the egg of an insect stimulate the cells in such a way as to create lenses, refractors, and reflectors of light in the insect's body.

Previous evidence has shown that certain deep-sea fishes house colonies of light-giving bacteria.

Fights Skyscraper Fires

FIRE in the top of a half-completed skyscraper apartment hotel in New York City recently did heavy damage because there were no near-by buildings of equal height from which to fight it, and delay was caused by the necessity of hitching two pumping engines together to force water to such a lofty blaze.

Profiting by this experience, the Fire Department had the pumper shown above built to order. With its six cylinders this $14,500 engine can pump 1,000 gallons of water a minute, sending a stream to the top of the Woolworth Building. On its huge pneumatic tires—another innovation—the machine can travel at a speed of forty-five miles an hour.

Uranium Aids Growing Crops

COMPOUNDS of uranium, a radioactive metal closely allied to radium, have a peculiarly beneficial action in growing farm crops, Dr. Keiso Hirai, of the Kyushu Imperial University, Japan, told soil experts recently assembled at Washington, D. C. His latest tests showed that when these compounds were added to the soil, the friendly bacteria that attach themselves to the roots of peas, beans, and clover and make atmospheric nitrogen available as plant food, would work faster and deliver larger amounts of the precious element.

The microscopic bacteria's important part in helping the farmer grow leguminous crops has been known for some time, and "experience has proved the value of inoculation of the seed with these bacteria in obtaining a thrifty growth," according to I. L. Baldwin, bacteriologist at the Wisconsin College of Agriculture. Such germ cultures are said to be an inexpensive form of crop insurance.

Refutes Attack on Oatmeal

WITH the worthiness of oatmeal in diet questioned by a British scientist, an American nutrition expert, Prof. Harry Steenbock of the University of Wisconsin, rises to its defense.

The conclusion that oatmeal not only lacks important vitamins but may contain a poisonous "toxamine," reached by Prof. Edward Mellanby of the University of Sheffield, England, after experiments with puppies, is repudiated by Prof. Steenbock. Repeating the same tests, he concludes that oatmeal is little less effective than wheat cereals in preventing rickets, a childhood bone disease. He doubts the existence of a "toxamine."

Organ Nearly Wrecks Itself

SO MIGHTY are the thunders of this pipe organ, and to be the largest in the world, that it has been necessary to place its console in a sheltered pit more than a hundred feet away from the main part of the instrument.

The organ occupies the center of the Roosevelt Memorial Park, in Torrance, California, near Los Angeles. The organist is seen seated at the keyboard in the foreground, while the instrument itself is housed in the structure beyond.

Previously the keyboard and the organist's bench trembled so decidedly that the player found it impossible to obtain with surety the delicate effects required for fine music. Eventual damage to the keyboard also was feared. The glass-covered pit was then constructed at a distance and connected with the instrument by electrical controls.

Tent Train Saves Pavement

WITH the aid of a unique "cloth train," engineers in Hawaii have at last successfully combated the rain that was wont to ruin their fresh and concrete roads. New road construction has long been a problem in that country where the annual rainfall is 200 inches and where it rains almost every day of the year.

The new apparatus consists of a number of wide, portable canvas coverings stretched on wooden frames and mounted on small wheels. As each new section of concrete road is laid, the "train" of canvas roofing rolls forward to cover it.

What Turns Animals White?

HAVE you ever seen a white woodchuck, or a white robin? Such strange examples of "albinos," snow-white individuals among animals normally dark, were recently described by Dr. R. W. Shufeldt, zoologist, of Washington, D. C., who has made an extensive study of this curious and unexplained freak of nature.

In Virginia, not long ago, a woodchuck was captured that was entirely white. Only a little less rare are the albino weasels and opossums occasionally captured in various parts of the country. Dr. Shufeldt obtained a male robin, partially white, at Stamford, Conn.; he has also found sparrows and finches that come under this name of "partial albinos." Quail, woodchucks and meadow larks are occasionally pure white. "White elephants," though proverbial, are rare; now and then a white squirrel is seen, and white mice are common and familiar pets.

All through the animal kingdom, including man, runs this odd trait, says Dr. Shufeldt. Even flowers show the tendency to produce albinos, as do insects. Albino insects are generally rare, says Dr. Shufeldt. Yet now and then you may see among the common yellow [illegible] ray butterflies that haunt clover fields, a single white individual.

Birds' Nest in Mop

THIS unusual location for a nest was selected by a pair of birds that appeared in Chicago and went looking about for a building site. Mrs. William Notacker, having left her mop idle on the back porch for several days, had occasion to use it and discovered that the birds had chosen it as a spot for their home, which was now well on the way to completion. The texture of the mop had saved the feathered settlers labor by constituting a sort of foundation structure for the nest.

The birds showed little fear, and, rather than disturb her tenants and spoil their summer's plans, Mrs. Notacker bought another mop. While nursing a family of six the birds became well acquainted with her. In the photograph above, the mother bird is seen bringing home a tidbit to her youngsters.

Mighty Natural Springs Could Supply Cities

NATURAL springs that are harnessed for water power, and others huge enough to supply the largest cities, are disclosed in a recent report of the U. S. Geological Survey. In this country, it states, there are sixty-five springs that could supply Washington, D. C. More than half of them, including many of the largest, occur in limestone, others in volcanic rock, and three in sandstone.

Silver Spring, in Florida, is believed to be the largest of the limestone springs. Each second, 6,149 gallons of water gush from its wide mouth—enough for New York's entire water supply! The water is marvelously clear and glass-bottomed boats are used to obtain a striking view of the fish and underwater vegetation.

From the black lava walls of the Snake River canyon, below the Shoshone Falls in Idaho, spurt the Thousand Springs, whose combined flow is nearly 6,500 gallons a second. High up on the canyon walls, they formed a spectacular waterfall nearly half a mile long and 200 feet high, until they were harnessed for power.

Montana has the only large sandstone springs: Giant Spring, near Great Falls, and the Warm Springs and Big Springs near Lewistown.

"Sidecarette" Carries Three

AT WIMBLEDON, England, motorcyclist has built what he calls a "sidecarette," a motorcycle with two streamlined side cars that comfortably carry his small son and daughter, and their pants have already covered several thousand miles. The wheels are smaller than those of the ordinary motorcycle. On each side of the vehicle's frame is attached a metal "cockpit" with wind shield and seat. In these the children can almost believe they are driving their own little cars along the boulevard.

Streamlined metal cars on either side of this "sidecarette" protect two small children from dust and weather. They have comfortable upholstered seats

Plans Plane to Fly Forward, Backward, Up or Down

AN AIRPLANE which, its designer claims, will reverse its course, going up or down like an elevator and forward or backward like a motor car without turning around or turning upside down, has been developed in Los Angeles, Calif.

Valentine Newbauer, the inventor, exhibits in the illustration at the right, a working model, which has a one-and-one-half horsepower motor and which he says will lift sixty pounds. The full size plane would have a wing spread of thirty-four feet and a 600-horsepower engine.

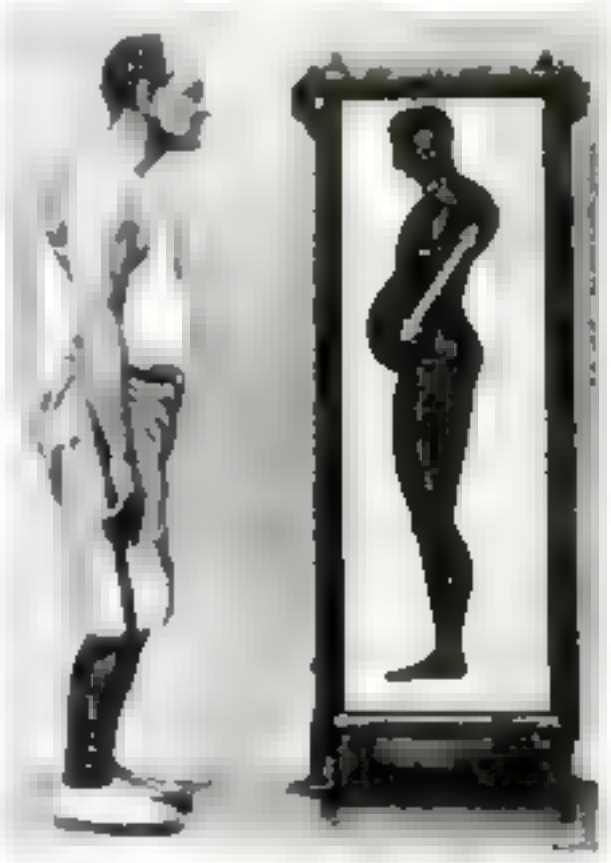
In design the unusual machine might be called a combined monoplane and helicopter. The horizontal double wings above, like the blades of a ceiling fan, are designed to whirl in either direction, causing ascent or descent. The propeller in front also is reversible. Newbauer, who has worked on his idea for ten years, says the plane can also be made to stand stationary in the air. In other respects the invention is much like the monoplanes in rather general use.

Valentine Newbauer with a model of his strange helicopter-plane. Reversible movement of rotating wings and propeller he claims, enables the machine to fly forward, backward, up or down

Flyer Takes His Car Along

A NOVEL plan by which an airplane can carry a motor car so that an aviator, landing on a field may then drive away to keep an engagement in a near-by crowded city where landing of airships is impossible, was recently demonstrated by a French pilot in Paris. The motor car is equipped with specially designed wheels which have large, heavily flanged hubs. Steel cable slings are attached to the body of the airplane and the slings are threaded around the car flanges. Then the airman soars aloft with the motor car securely suspended.

If the plane becomes disabled, but a safe landing is made and its wheels are intact, the motor car can be used to haul it to the nearest hangar for repairs. Also a damaged part of the plane may sometimes be replaced temporarily by a similar part taken from the automobile. Some engine parts, for instance, are easily interchangeable.



Dr. George B. Emerson and his manikin show the ugly effect of incorrect posture

Manikin Teaches Posture

TO TEACH correct posture and to demonstrate the harmful effects of poor posture, Dr. George B. Emerson, director of physical education for men at Boston University, has devised the manikin pictured at the left. The posture illustrated—shoulders drooping and stomach protruding—is the result, he says, of sitting for hours every day in an office chair, with the weight usually rested on the tip of the spine. It is a frequent deformity among American business men. Dr. Emerson stands beside his manikin in a similar posture. As remedies he advocates exercise and attention to defects, which develop mostly through neglect.

Only Four Basic Odors

THERE are just four fundamental smells, two chemical engineers of Boston, Mass., recently told the American Chemical Society. All the odors, say E. C. Crocker and L. F. Henderson, are blends of these scents, which they name "fragrant," "acid," "burnt," and "caprylic." The last is the odor of certain evil-smelling chemicals. All smells apparently are detected by nerve-endings in the nose. Tastes, physiologists have long agreed, can be reduced to "sweet," "sour," "salt," and "peppery."

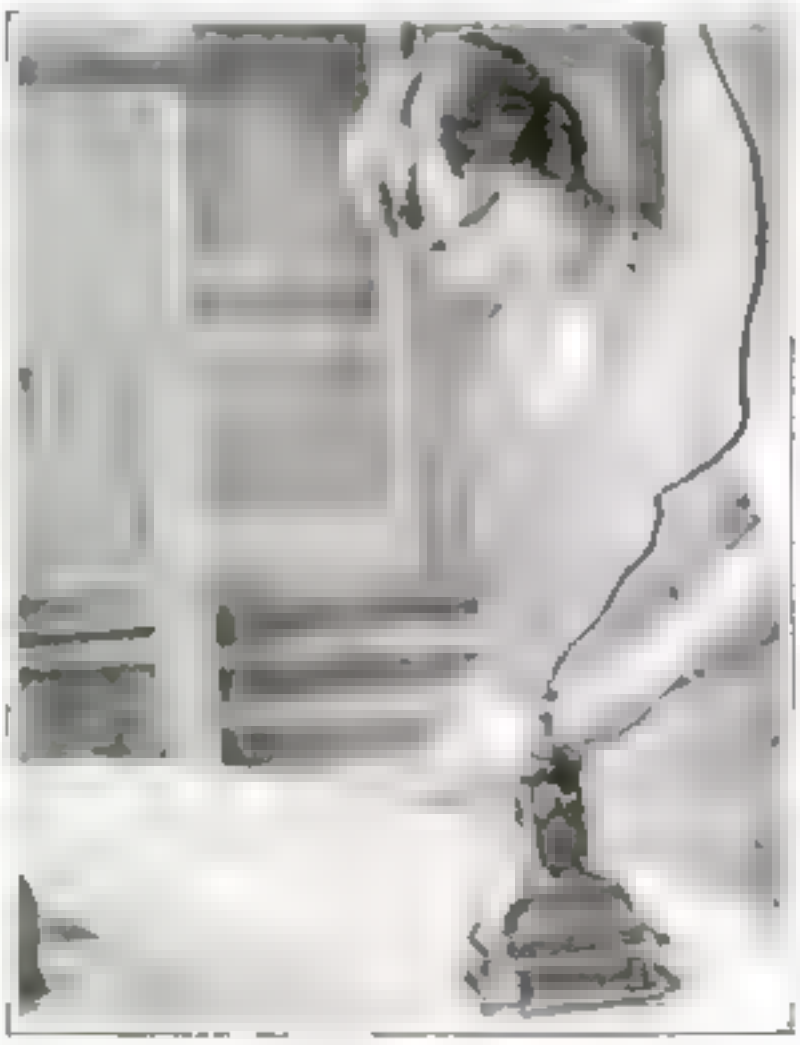
How a French aviator carries his motor car with him. Steel cable slings, suspended from the body of the plane, are threaded around flanges on the hubs of the automobile wheels

Improved Tools *to Make* Housework Easy

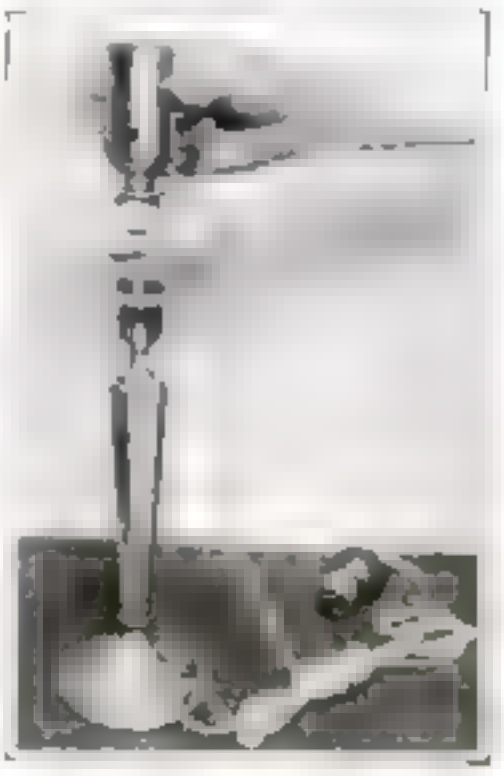
On the end of a sliding rod running through a hole in the top of this salt shaker is an agate ball. When the shaker is inverted the rod and ball slide forward releasing a sprinkle of salt. With the shaker upright the ball slides down and covers the openings

With this shaker you season your food by pressing a plunger. Press it on one side and salt comes out on the other side, pepper. Both sides are suitably labeled. Filled from the bottom the device is said to be proof against moisture

The triangular strainer of the coffee percolator pictured above is an extension of the lid and fits into the spout. Raising the hinged lid lifts the strainer at the same time, making the spout accessible for washing. An improved type of inner coffee holder is said to give better percolation and fuller flavor, while the strainer is designed to insure clear coffee, free from grounds

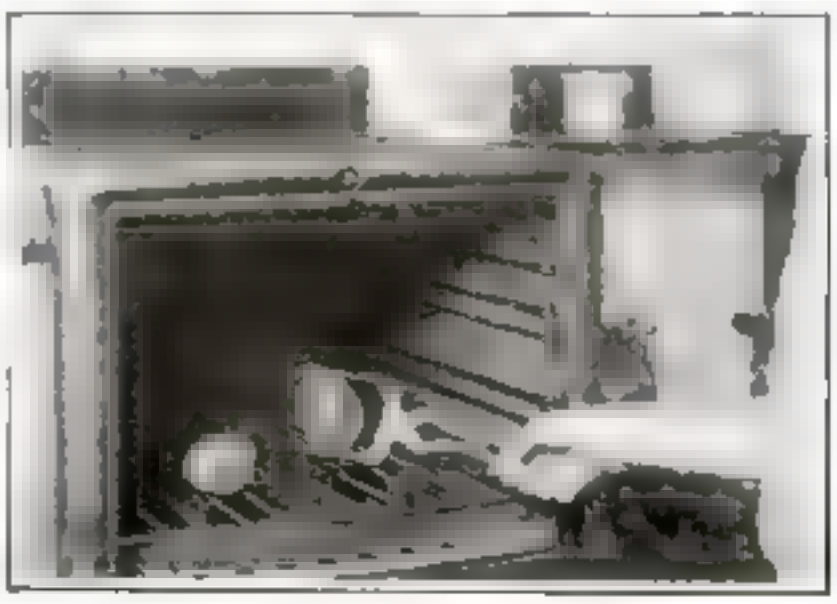


You can set this electric iron for any degree of heat you desire, the makers claim, and it will get neither hotter nor colder. Low heat for silks and laces, high heat for coarse materials —either can be obtained by turning a regulator button placed at the back of the plug



You can modernize your candlesticks with a newly invented adapter that makes it possible to burn electric candles in them. The device is an electric light socket, mounted on a rubber base which is inserted in place of the usual tallow candle. The socket then can be used to hold an ornamental "candleflame" bulb which is free from unsightly dripping wax and besides offers no fire hazard

You don't have to use a pad or cloth to avoid burning your fingers if you have these bulldog tongs to pick up hot cooking utensils. They are also helpful for setting pans and dishes in out-of-the-way places, as on the back of a deep shelf

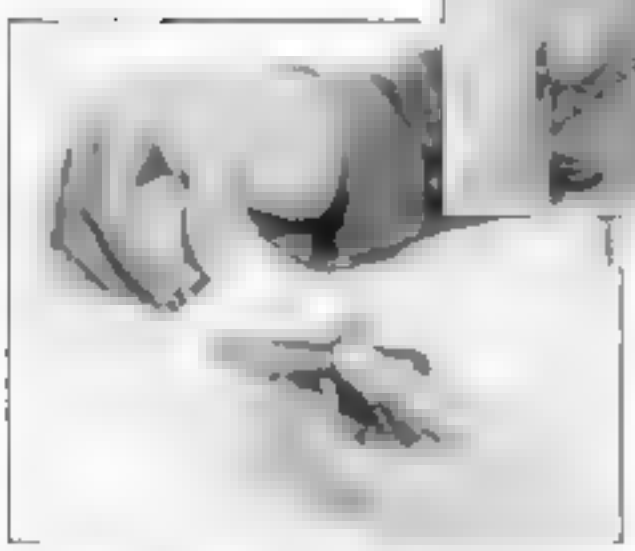


With one hand you can easily pick hot potatoes from the oven, or vegetables from boiling water with the aid of tongs hinged in such a way that pressure on the handles closes them. When pressure is released, a spring releases potato

This odd-shaped ladle has, beside its cup-form bottom, a strainer attachment by which vegetables may be drained on way from pot to dish by a turn of the wrist

This electric coffee percolator can be taken apart for washing. The heating unit is really a separate little stove upon which the perforated and recessed bottom of the pot fits

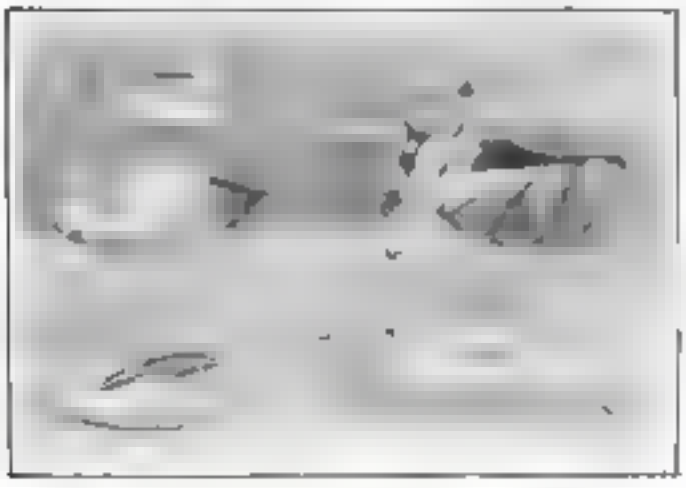
A handy orange peeler. After you have cut a neat groove around the orange with the small blade at the center of the peeler, the spoon end is inserted under the skin on each side, removing it quickly and easily



For the picnic lunch this tube shakes salt from one end, pepper from the other. Both ends are covered with caps when not in use

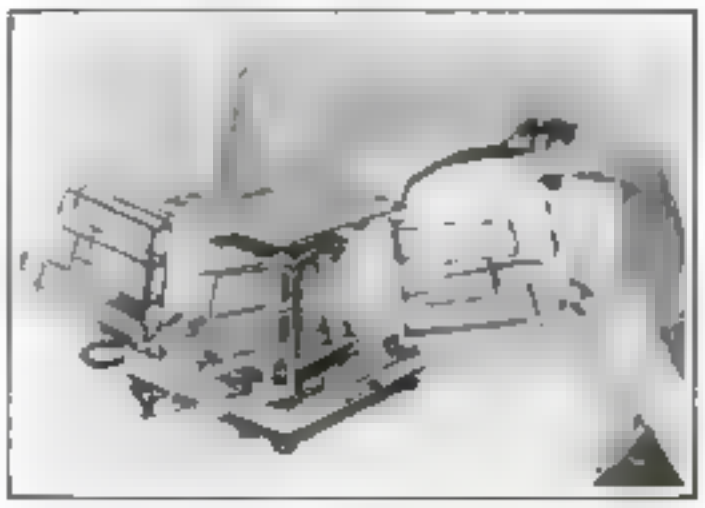
These space-saving refrigerator dishes nest together, making the most of room in the ice box. Perforations near the rim of each dish assure ventilation. The contents remain fresh and cool, and protected from contact with other food

In this open-work metal box, that swings out of the way under the sink, is a waterproof paper bag that holds the day's accumulation of waste. The bag, filled and discarded, is replaced by a fresh one



A new serving utensil that prevents spilling food on the tablecloth is a spoon with a cover that you can lift with your thumb. The handle is shaped to fit the fingers. The device ... may be used for draining vegetables

To keep pictures straight on the wall, these handy new points are stuck, two to a picture, in the bottom of the frame at the back. Their sharp tips catch on the wall and prevent the frame from twisting awry. The tool that is used for inserting them comes with them



Four slices of bread are turned all at once by this ingenious toaster. The slices are inserted in hinged frames which swing like doors. Turn one by its handle and the other three swing at the same time

What Everyone Asks *about* Flying

Why a Plane Can Rise in the Air How the Pilot Can Direct Its Course—Other Common Questions Answered

WHAT keeps an airplane in the air?

Air pressure on the wings. The rapid motion of the wings, which are set at an angle, compresses the air below them and reduces the pressure above them. Wings exactly parallel to the line of flight would only cut the air, so the "leading edges" are set a few inches higher. Riding in your car you would get a lifting effect by raising the front end of the top.

Is the pressure on the underside of the wings enough to keep the airplane up?

Yes, but only one quarter of it is direct "lift." The remainder is the result of the partial vacuum on the upper side, caused by the "slice" which the tipped wing has cut in the atmosphere. As a boat's prow cuts the waves, the parted air is shot upward by the leading edge, leaving a "hole" of thin air on top of the wings. The partial vacuum permits atmospheric pressure to support the wing.

Why is fast motion necessary for flight?

To produce the pressure necessary to lift the plane's great weight.

How can a glider stay in flight without any engine at all?

The glider planes like a bird, taking advantage of up-flowing air currents. When the currents cease, the glider comes to earth.

What effect does greater speed produce?

It causes more resistance on all parts exposed. Resistance increases as the *square* of the speed; if you double your speed, you increase resistance four times.

Does more resistance require more power and fuel?

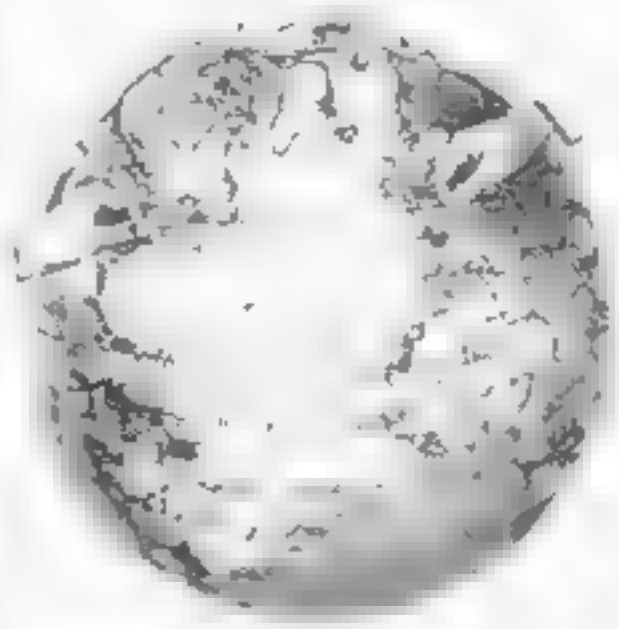
Yes. Fuel consumption increases as the *cube* of the speed; double your speed and you need eight times the fuel.

Why do not airplanes rise at once from the ground?

For the same reason birds do not—they must attain such a speed that the air pressure and lift will overcome gravity which holds the weight to earth.

How is "see-sawing" prevented?

At the ends of the wings are hinged sections, called ailerons, connected by wires with the pilot's control stick. When a sudden current of air strikes under a wing, the pilot raises its aileron to decrease the vacuum above, and lowers the other aileron to increase the vacuum above it. This action steadies the airplane.



WHY is the "great circle" New York-to-Paris air route the shortest? On a flat map, as below, this route appears to be a curved one. Yet if you stretch a string between the two cities on a globe map, as above, you will see that the string marks a bee line between the two cities. The explanation is that a flat map distorts the curved surface of the globe

When flying out of sight of land, how can I tell whether I am right side up?

A "turn and bank" indicator tells you if the wing is tipped, as when turning. Your inclinometer tells you whether you are headed up or down.

How do I know how high I have climbed?

By looking at your altimeter. This instrument measures pressure of the atmosphere, which decreases as you rise, causing a pointer to travel over a scale that registers the height in feet.

Does the pointer change instantly?

No, it takes some seconds to act, so a rate-of-climb indicator tells you how fast you are climbing or descending.

How can I tell the direction in which I am going?

By watching your magnetic compass and your earth-inductor compass. This last is a new invention, utilizing a generator turned by an air motor. You set the desired course and steer to it, keeping the indicator on zero. Your drift indicator tells you whether a side wind has thrown you off your original course.

Since the airplane does not touch the ground, how is its travel measured?

Your ground-speed indicator measures the miles according to the speed which your plane is traveling. Your tachometer measures the revolutions of your engine and tells you whether it is running properly.

What is the fuselage?

The hull, in which the pilot sits and in which essential parts are inclosed.

Why is the nose of the fuselage usually bluntly rounded, instead of being sharp like a ship's bow?

To get the best streamline effects, with minimum power. Wind resistance is less with this form. The sharp stern enables the parted air currents to flow together smoothly.

What shape is the "fuselage" of a fast flying bird?

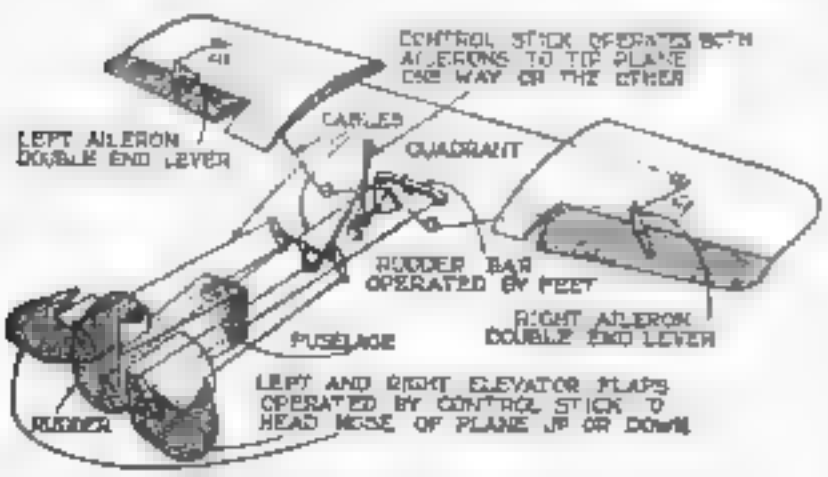
The breast is rounded, and the rear is tapered.

Why are the propellers in front of some airplanes, and in the rear of others?

The wing structure can be either pushed or pulled through the air. The propeller in front has an unbroken air stream to work in and is gaining in favor with aviation men.

Why is the noise made by airplanes so deafening?

Because of the high power and great speed of the engines. Mufflers can be attached, however, and doubtless will be used in the future on passenger planes. Some power is lost thereby because there is some "back pressure" caused which increases the load on the engine.



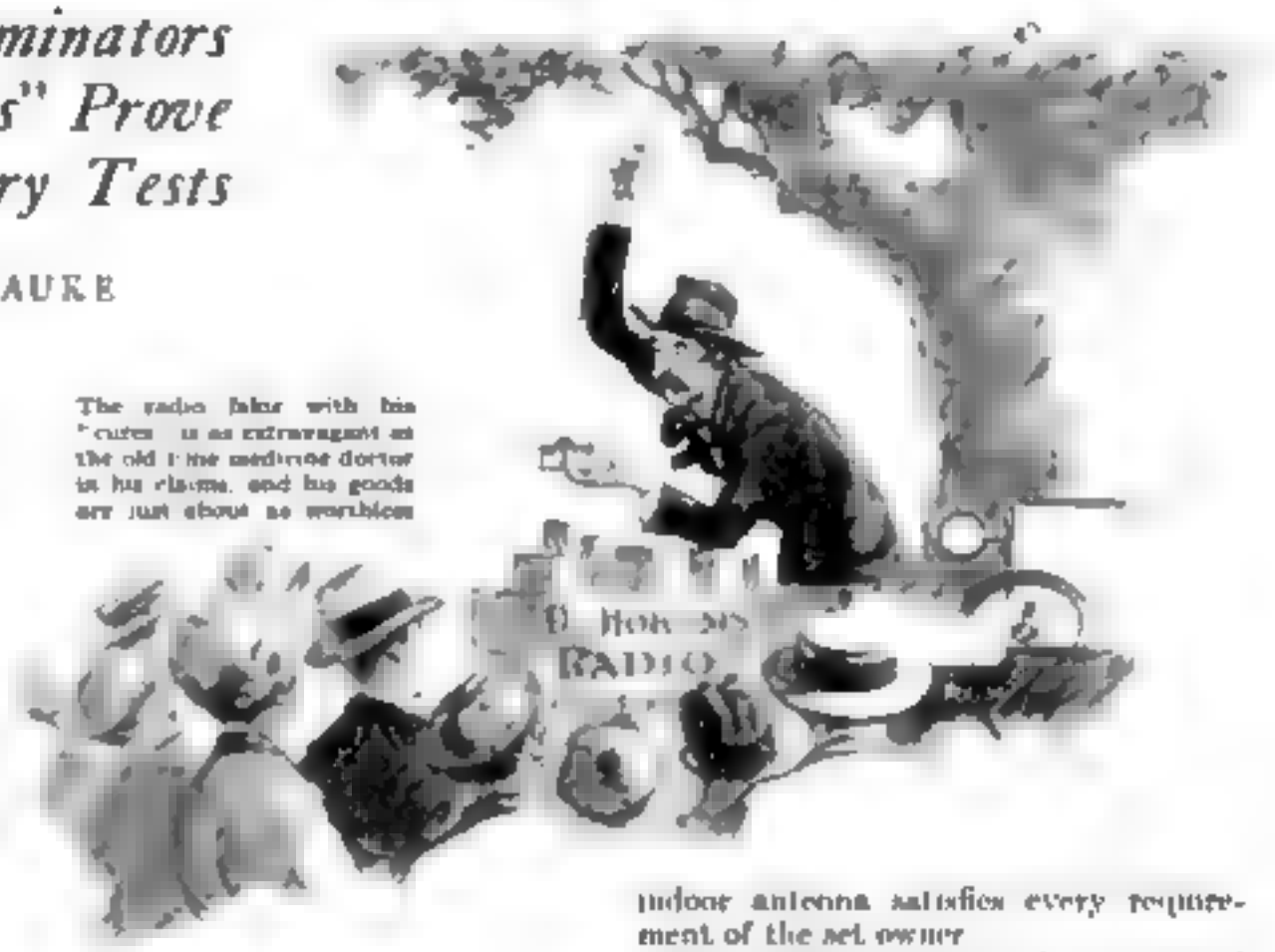
Skeleton diagram of airplane, showing controls by which a pilot governs his altitude and balance and steers his course

How lifting force is produced by an airplane wing cutting the atmosphere. Pressure of the air stream (indicated by arrows) beneath the wings produces one quarter of the "lift." Partial vacuum above the wing permits atmospheric pressure to supply the additional three quarters

Tricks *of the* Radio Quacks

So-Called Static Eliminators and Battery "Medicines" Prove Worthless in Laboratory Tests

By ALEXANDER E. SENAUKE



The radio fake with his "cures" is as extravagant as the old time medicine doctor in his claims, and his goods are just about as worthless

ARE you bothered with static? Do you suffer occasionally because of an exhausted storage A-battery?

Is your radio set subject to fading?

These and hosts of other real and imaginary radio troubles are easily cured if you believe the claims of radio quacks. No matter what your particular trouble is, there is available a quack expert, who will take your money and guarantee a sure cure. Some of them even offer a single device that is supposed to cure every possible ill. And of course these claims are as worthless as the guarantees.

Devices to eliminate static are the most numerous because static, like hot weather affects us all rich and poor. An expensive radio receiver suffers from static just as much as does the cheapest, homemade one-tube outfit. With millions of radio fans enduring the rasping noises of static whenever weather conditions are bad, there is an enormous demand for static eliminators.

BUT so far no really successful eliminator is available. In fact any of the larger radio concerns would pay almost any price for a real solution of the problem of eliminating static. But despite long and patient experiment static has proved a baffling and unsolvable puzzle to our most eminent electrical engineers and radio experts. At worst the so-called static eliminators that are offered for sale are plain fakes. At best they will eliminate the broadcasting as well as the static.

Several varieties of these eliminators have been tested in the radio laboratories of the Popular Science Institute of Standards. Every one has proved worthless.

All sorts of absurd claims are made for some radio cure-alls. In addition to eliminating static, they are supposed to increase the sensitiveness, make the set more selective and make the batteries last months longer!

Storage batteries, like automobile tires, wear out and owners, faced with the prospect of buying new ones, prove easy marks for sellers of battery "rejuvenating compounds." All you need do, according to some of these gentlemen, is pour their magic solution into your old battery and—presto!—it becomes better than new.

Some of these rejuvenating solutions are nothing more than extra strong battery electrolyte, which will spur the battery into action for a short time if there happens to be any active material left on the plates. It is about as effective as digging the spurs into a dying horse to make him go a few steps more before he drops. Other battery rejuvenating solutions consist of powdered salts of various kinds that cannot conceivably do any good and may do harm.

All radio sets need some kind of antenna system and the type of antenna depends on the set, the conditions under which it is to be operated and the type of reception you want. In some cases a loop is used. In others a long outdoor antenna is required for best results. And there are, of course, situations wherein an indoor antenna satisfies every requirement of the set owner.

But in spite of the fact that a piece of plain wire is just as effective as anything else, there are various forms of fancy equipment sold for antenna uses.

For the man who wants to get distance a long outdoor antenna is needed with most types of sets. Frequently there isn't space to erect a hundred-foot antenna in a straight line. The radio fan faced with this problem is offered various kinds of special antennas, in which a wire of the required length is wound into a spaced coil a foot or two long. This coil is to be mounted on the roof and one end of it then connected by the lead-in wire with the radio set. The idea, of course, is that the coil is as effective as the same amount of wire strung out in a straight line. But tests show that it doesn't work out that way. The coil of wire actually is no more effective in bringing in signals than a plain piece of wire as long as the axis of the coil.

THEN there are the special antenna systems consisting of a pole usually of metal, with a hollow metal piece on top. There is no magic in a metal construction of this type. For all practical purposes it is no more effective than a piece of wire of the same length in the same position.

Another idea for the elimination of static is to bury the antenna under the surface of the ground instead of erecting it high in the air. The theory is that you can receive the ground wave instead of the air wave and that there is little or no static transmitted through the ground. But tests made at the Popular Science Institute do not bear out these theories. Burying the antenna results in weaker signals and exactly the same proportion of static.

Sure Protection

DR. L. W. AUSTIN, in charge of the radio transmission laboratory of the U. S. Bureau of Standards, recently stated that no way of overcoming or eliminating static has been discovered. Money spent on so-called static eliminators therefore is wasted. Before you buy such devices, or other radio equipment, be sure it will do what is claimed.

The Popular Science Institute of Standards maintains large laboratories to protect you in your purchases of radio and other semi-technical products. The advice of its engineers is free to readers of the magazine.

Hints for Radio Beginners

Neat Wiring Made Easier

How to Prevent Loose Connections — New Ways to Better Results

NEAT looking wiring in a radio receiver is an advantage only if the neatness is the natural result of care in making each connection as short as possible. Spacing the wiring so that no two wires run close to each other is necessary only for the grid and plate connections. The remaining wires, which carry power to various points in the receiver, can be bundled together in one cable. Such a procedure is desirable in many hookups because it helps to eliminate stray inductive and capacity effects.

The coil looking device in Figure 1 is designed to facilitate this grouping together. Although at first glance it looks like an over-sized centipede, wiring a multi-tube receiver should be greatly simplified by its use. Essentially it consists of a long, flat strip in which are moulded four thin sheets of brass with a number of lugs on each sheet. These lugs are arranged in such a way that it is possible to make connection to any one of the four connector strips on either side of the form at any point. You will note that the lugs are in groups of four with a separate pair at each end. At one end you connect the plus A and plus B wires from the batteries and at the other end attach the minus A and C wires. Then the terminals of the sockets, transformers and other apparatus that are ordinarily connected to these wires are, instead, connected to the nearest lug. When the wiring is complete the extra lugs are cut off and a neat and efficient job of wiring is the result.

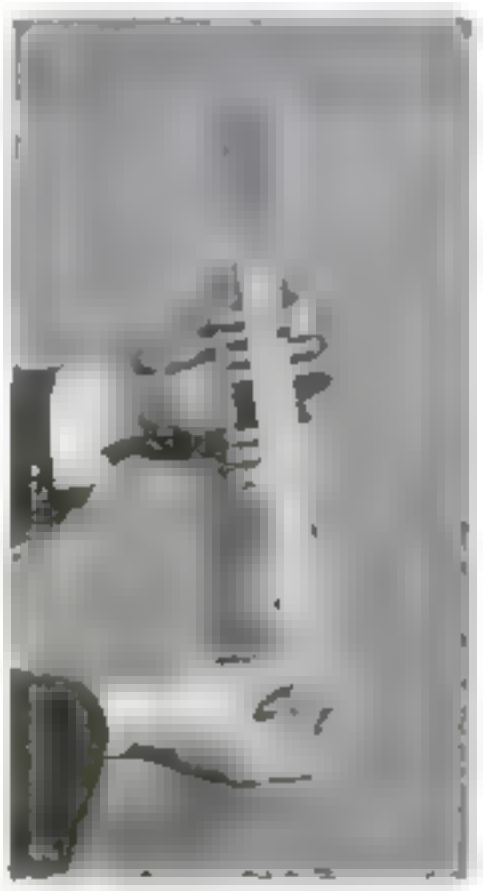


Fig. 2. Wiring is easier and neater with this connecting strip with lugs convenient for all terminals

Binding Posts That Hold

THE manufacturer of a radio set may do a perfect job of wiring a receiver, with all connections correctly made and electrically perfect, but all his attempts to make sure that you will not have trouble will go for naught if you do not see that binding posts are kept tight. Don't take anything for granted. If the set suddenly refuses to function or queer noises develop, check up on every binding post and battery terminal to make sure that they are tightly clamped to the wires.

Figure 3 shows a novel type of binding post that can't come loose. It is made in two pieces, an outer cap that is hollow and an inner solid portion that is fastened to the binding post panel. A hole is drilled through both the cap and the solid portion but the holes do not line up unless the cap is pressed down against a moderately stiff spring. After the cap is pressed down and the end of the wire inserted in the hole the spring causes the side of the hole in the cap to exert a constant pressure against the wire and there is no chance for a loose connection.

IF YOU are thinking of building a B-battery eliminator, don't fail to study the article on pages 74 and 75 of this issue, which describes the most improved designs and methods of construction. It will help you to get exceptionally satisfactory results.

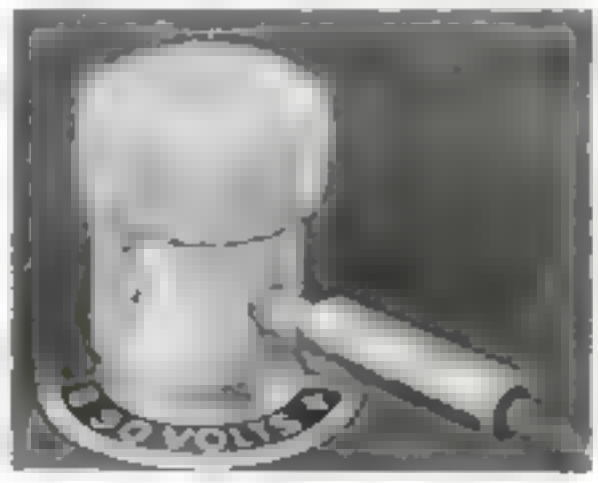


Fig. 1. This novel binding post holds the wire by spring pressure from working loose

Locating the B-Eliminator

OFTEN B battery eliminators are accused of producing a bad hum in the loudspeaker when the trouble really is in the location of the B-eliminator with respect to the radio set. As a general rule, it is a mighty good idea, if a noticeable hum is produced, to move the eliminator away from the radio set and see if this doesn't help the situation.

Of course, the possibility of difficulty depends on the arrangement of the parts in the set and the wiring. However placing the B-eliminator about three feet from the set is good practice. Don't have the B-eliminator too far away, as other troubles may crop up due to the long leads.

Another good idea is to make sure that the cord connecting the B-eliminator with the light socket is kept away from all other wires. Designers of some types of automatic relays apparently have neglected this point. They have arranged the wiring inside the relay so that there is a definite magnetic pickup between the wires that carry the current through the relay to the B-eliminator and the filament circuit that operates the relay magnet. If you experience trouble with a hum, be sure to see if leaving the relay out of the circuit will improve results.

Shield the Detector Tube

EVEN a B-eliminator that is practically hum-free will cause a decided hum with some types of sets if the eliminator is placed too close. The hum in such cases is due to the effect of a stray magnetic field which affects the flow of electrons in the vacuum tubes in the set. The detector tube is especially sensitive to this disturbance.

Moving the eliminator a few feet away from the receiver is the simplest way to stop the hum, but if this is not convenient, moving the eliminator may be avoided by carefully shielding the detector tube and grounding the shield. The shield should consist of a metal cylinder just large enough to slip over the detector tube. Of course it should clear the binding post of the tube socket.

A B C's of Radio

THOUSANDS of radio fans get poor results with dry cell B-batteries because they do not realize what happens inside the pasteboard case when the battery approaches exhaustion. When a 45-volt block gets down to 35 volts it should be discarded, the makers claim; but frequently the radio fan finds that reception is fairly good with batteries exhausted considerably beyond this point. And so he keeps on using them, and each night reception is just a little bit worse until it becomes hopelessly weak and noisy.

If you want your set to operate at full efficiency be careful to replace the batteries when the voltage falls to the specified figure. Then you won't have to apologize for the poor results you are getting when your friends drop in for the evening.

Sam Loyd's Page of Posers

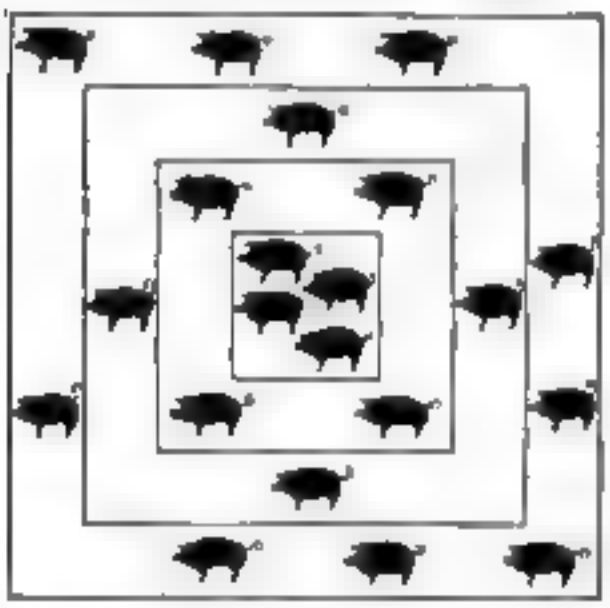
Give Your Mind a Speed Test

Five Problems to Measure Your Logic and Ingenuity

UNUSUAL puzzles that not only entertain, but actually test and exercise your mental faculties, sharpening your wits and stimulating your imagination are presented here each month by Sam Loyd, world famous puzzle maker They range through many departments of the mind They run from simple mathematical problems to others that measure your ingenuity or test your powers of observation.

Try your capacities on the varied questions, tune your solutions, then turn to page 137 and see how well you have done

Can You Pen These Pigs?



BARNEY O'MORE went over to inspect the piggery of his neighbor. "How many grunters are you bringing up this spring?" inquired Barney as he peeped into the pens and tried to count the lively inmates. "Exactly twenty one," replied his friend, Tom McCann, "and they are all doing nicely "Well, at any rate," continued Barney "you have just the right number, according to my famous ancestor, Rory O'More, who discovered the luck that lingers in odd numbers According to Rory's instructions a fellow should have just twenty-one but he should pen them in four groups so that each pen would contain an even number of pairs and one odd pig "

McCann had his pigs in four pens all right, compartments "nested one within the other, but they were not separated to conform to the famous O'More formula.

Now, how easily can those porkers be redistributed to comply with the rule that there must be four pens, each to contain an even number of pairs and one odd pig?

Here is a little poser that will not yield to orthodox arithmetic. You must exhibit some ingenuity as well if you are to work out an acceptable answer, which is given on page 137. A triumph in ten minutes will betoken a bright mind inclined to a sense of humor.

An Arithmetical Courtship

DANNY went over to urge Kate to name the day

"This proposal is entirely unexpected," gasped the blushing maiden, "but I will marry you when the week after next is the week before last "

"Had I received this promise yesterday " said Danny, "the waiting would have been six days shorter "

On what day of the week did Danny pop the question?

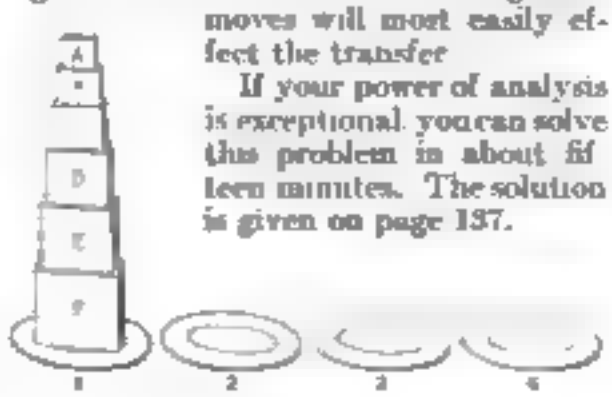
Danny's reply was instantaneous, because the subject was the most important in the world to him just then and he had always been particularly good in mathematics and in reasoning swiftly and logically. You should be able to answer in ten minutes. See page 137 to find if your answer is correct.

Moving a Pyramid

THE proposition shown below is to transfer the pyramid of six cubes from plate one to plate two, moving the cubes one at a time to any of the plates, but at no time placing a cube upon one of a smaller size When the puzzle is solved the pyramid will be transferred to plate two and the alphabetical order will be just the same, from top to bottom, A, B, C, D, E F

The task can be accomplished in a rather surprisingly small number of moves and the test is for your speed in mastering the situation and determining what moves will most easily effect the transfer

If your power of analysis is exceptional you can solve this problem in about fifteen minutes. The solution is given on page 137.

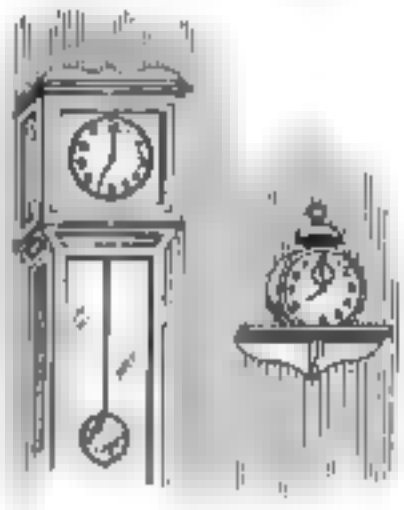


A Rebus Memorandum

I ASKED the sign maker to make a signboard for me exactly four feet in length. Then the fellow, who is a rebus crank, made a little sketch in his memorandum book which corresponded to the design reproduced below. I scratched my head for quite a while before I made out how his notation could be interpreted from a rebus standpoint to indicate four feet

It did not take the rebus fancier anything like eight minutes to conceive his idea, but if you can, in eight minutes, discover a phonetic translation of that group of letters and one numeral to describe a four-foot dimension, then you are entitled to boast of your imagination and talent for rebus riddling. The answer is on page 137.

The Clock Race



YESTERDAY my clocks started to race. The alarm clock gained one minute an hour on regular time, while the grandfather's clock lost two minutes an hour.

The race ended today when the alarm clock rang eight and the grandfather's struck seven. Who can tell at what time yesterday the race started? A ten-minute canter in mental arithmetic The answer will be found on page 137.

Another page of Sam Loyd's puzzles to help you test your mental abilities will appear in next month's issue.

A House *with* 30 Servants

Like O. H. Caldwell, Almost Anyone Can Have Electrical Helpers Handy in Every Room—What It Costs to Keep Them

By JOHN R. McMAHON

ARISTOTLE, about 2230 years ago, thought slavery a necessary evil. He pointed to the only alternative:

"If every instrument would accomplish its own work, obeying or anticipating the will of others . . . if the shuttle would weave, or the 'pick' touch the lyre, without a hand to guide them, then chief workmen would not need assistants nor masters slaves."

The other day I asked the spirit of the Greek philosopher to accompany me on a visit to a house in Bronxville, New York. On the way Aristotle said:

"The owner of this house must be a rich man, since you tell me that he has at least thirty domestic slaves."

"He is not rich as we reckon it," I replied, "but in comfortable circumstances. He is widely known in the United States, however, as a member of the Federal Radio Commission—an umpire of the ether. His name is Orestes H. Caldwell."

"The first part of his name sounds familiar," commented Aristotle. "So this is the house. It is modest enough. But where are the slave quarters for thirty servants? Where is the granary for feeding them? And where is their workshop?"

"The servants live in the partitions," I explained, "which saves the expense of housing them outside and also makes them more readily available. The feeding problem is solved by a distant refectory called a power house, and no servant eats except when he works. The units of the workshop are right in the house. Each machine has assigned to it from one to a dozen slaves, who hop from the partitions and get busy at a given signal."

"YOUNG man," said Aristotle sadly, "we had lyres of several kinds in ancient Greece, but none so flagrantly fanciful as yourself. I fear this world has developed backward, since it has not progressed in respect for truth. Kindly permit me to return to Hades, where veracity is yet honored."

There are, of course, millions of homes in America which keep one or two servants lodged in walls and partitions. The distinction of the Caldwell residence is the large number of its equivalents for the slaves of olden time and the hired help of yesteryear, together with the wide, convenient distribution of these mechanical employees through the house. Here is an all-electrical house. Everybody who uses a little current wants to know about the use of a great deal of it, what can be done with it, what it costs and everything.

The meters of the electrical home are housed in a locked box on the wall outside the meter reader need not bother the occupants

Cost is an early question to which there is often an aggravatingly delayed answer. If the skeptical and somewhat huffy spirit of Aristotle had put this query, I would have given him a frank and prompt reply. The average home in America uses 365 kilowatt hours of current yearly, practically all for light, and at a charge of seven cents plus per kilowatt hour (1,000 watts for one hour) pays an annual bill of $27. In contrast, the Caldwell house uses more than ten times as much or 4508 kw. h. Of this I figure the lighting component, on the quantity basis of the national average but at a twelve-cent local charge, amounts to $43.80. There is left a power consumption of 4135 kw., which at five cents per kw. adds $206.75. The total annual bill for electricity is $250.55.

It seems a lot of money, but what servant can be hired and fed today at five dollars a week? And the best human servant lacks the versatility and efficiency of the electrical toiler. "Just a minute, ma'am," and "I can't be in two places at one time" are never offered as alibis by the cheerful genii of the partition. We spoke of thirty servants. Doubtless that is a fair comparison with antiquity, perhaps even with our conditions a few decades ago. And it is a large understatement to equalize for our time the multiple labors of the wires in this dwelling with the activity of one person aided with average home equipment.

SEPARATE meters register the current used, one for the lighting system and one for the power line. The meters are neatly housed in a locked box just outside the house and the meter reader does not have to bother the occupants. It is a small but worth while boon that prompts the question.

How about the iceman? That dripping visitor is unknown, and so are the coalman and the laundryman. The intrusion of the grocer and butcher must be borne with for the time being, until the art of conveying food over a wire is developed.

It may be well to emphasize that the Caldwell house is no electrical stunt dwelling. It was equipped gradually for personal use and not to show or prove anything. The owner happens to be an electrical engineer of an inventive turn and he has amused himself with one or two unusual devices, but his chief aim was practical, and almost anyone can have a duplicate of his standard installations. He is on the sunny side of forty, born in Kentucky and educated in Germany and in our Middle West—Purdue University. He has been an editor of electrical and radio magazines since 1907.

After seeing Mr. Caldwell's home workbench with its hand electric drill clamped

The basement includes complete electric laundry workshop with a workbench and electric tools, and a gas-heated steam furnace

in a vise and the astronomical toy which he made for his children, I surmised that he sometimes wished he did not have to be an editor, or to spend so much time in Washington acting as a national "traffic cop" of the ether. This man surely has the makings of an inventor, and a notable one at that. When he was just fourteen he invented an underground power system for trolley cars. A traction company bid $50,000 for the invention, which the boy's father declined, believing it worth more. In the end another device was adopted. The loss of money was probably less than the loss of creative stimulus. In high school theatricals the youth officiated as stage electrician. He began to play with radio in its early days and qualifies as an expert

Most of the wiring and equipment of the Bronxville house was put in by local mechanics under his general directions; but Mr. Caldwell reserved all the radio installation for himself. You may wonder how this could be any kind of a job when you see a quite usual type of cabinet set with indoor aerial standing in the living room. Well, there are some frills. That radio is wired to outlets in every room in the house, including the kitchen.

IF THE cook wants a little music while the chops are broiled by the electric stove, she can don the earphones or turn on the loudspeaker. A clock attachment to the radio gives automatic time control. By this means the children, tucked in bed, receive their allotment of bedtime stories. The parents enjoy the last half hour of a symphony concert after returning and the music terminates on the predetermined schedule. Likewise the sleeper may be pleasantly aroused to another day by the "Good morning" of the radio voice and he may go through setting-up exercises in the fit costume and place.

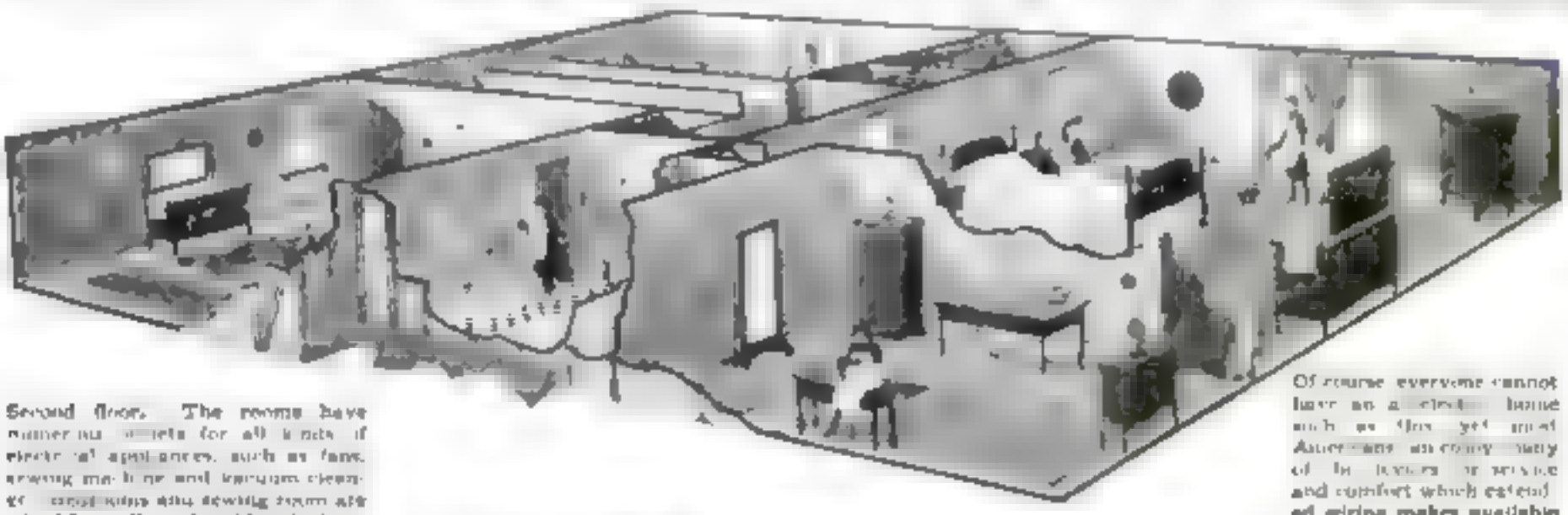
Setting the control clock that automatically cooks the meal in the kitchen electric range

Of course, the electrical house has a multitude of outlets. You can plug in most anything anywhere. Take your choice of music, massage or muffins. Cold feet are warmed without a hot water bottle and a feverish head is cooled by the capable servants in the partitions. There are more than a dozen outlets in the living room and not less than twenty in the kitchen, while the total for this house of eight rooms is around seventy-five. The outlets are strategically distributed between ceilings, walls and baseboards, and a very few are in the floors. In comparison, the average house has a third the number of outlets.

"I guess that house was wired when it was built," observes a reader. "Ours wasn't, and it would cost too much to do it now."

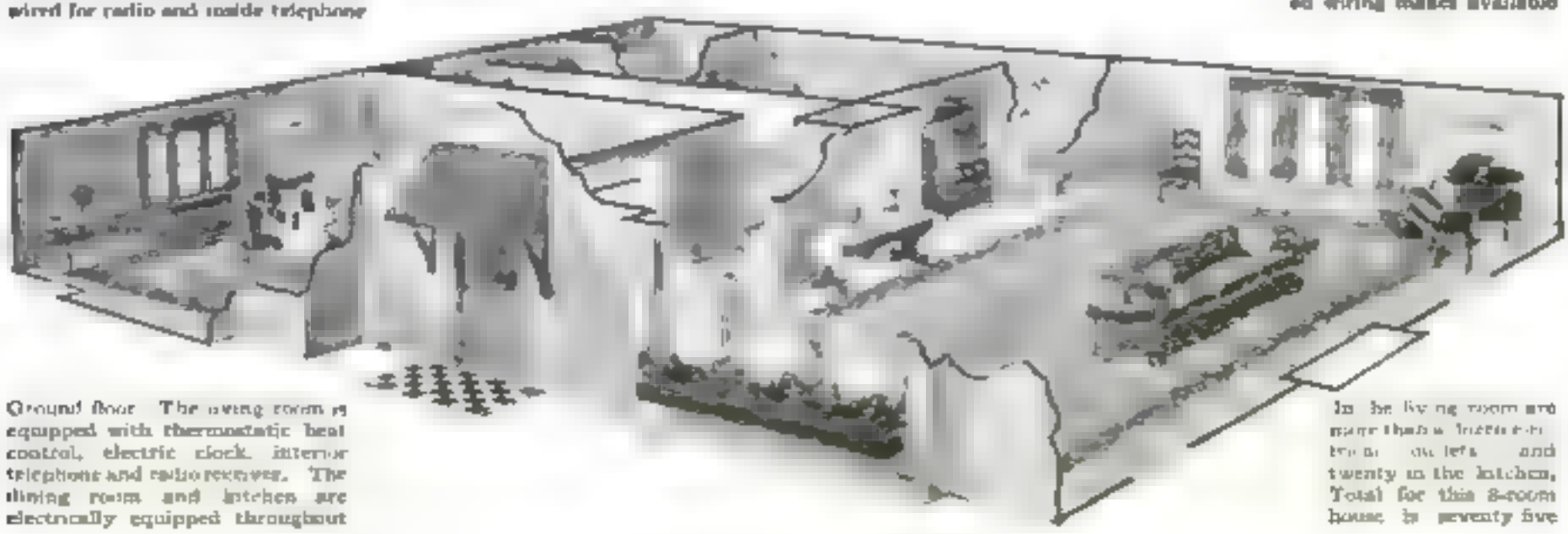
BUT it happens that the Bronxville dwelling was bought ready built by Mr. Caldwell some ten years ago, and most of its extensive wiring —in flexible metal cable, by the way—has been put in since. Doubtless it is better and less expensive to wire when building, but the job can be done afterward and the cost is not great. Complete wiring adds inestimable possibilities of comfort, while it enhances the value of every house. It entails just the first cost, upkeep being virtually nonexistent. There are all kinds of useful devices, for regular and emergency purposes, which such wiring makes available. It is also well to be prepared for tomorrow's new invention in machine or appliance: some new current-user on a par with radio and refrigerator and oil burner.

The location of outlets is important. A floor connection is generally undesirable because dirt, water or mechanical interference may cause trouble. The baseboard is safer but may contribute to backache. A wall outlet about three feet above the floor level saves stooping and is most protected. Dining table appliances, as grill, toaster (Continued on page 146)



Second floor. The rooms have numerous outlets for all kinds of electrical appliances, such as fans, sewing machine and vacuum cleaner. Bedrooms and sewing room are wired for radio and inside telephone

Of course everyone cannot have an all-electric home such as this, yet most Americans enjoy many of the luxuries or service and comfort which extended wiring makes available



Ground floor. The living room is equipped with thermostatic heat control, electric clock, interior telephone and radio receiver. The dining room and kitchen are electrically equipped throughout

In the living room are more than a dozen outlets and twenty in the kitchen. Total for this 8-room house is seventy-five

Kinks *for the* Motorist

Simple Ways to Make a Trouble Lamp, Wheel Puller, or a Baggage Rack—Ten Dollars for the Best Idea

O. E. Abernethy, of Hickory, N. C., wins the $10 prize this month for his suggestion of a way to discourage the auto thief (Fig. 4). Each month POPULAR SCIENCE MONTHLY *awards $10, in addition to regular space rates, to the reader sending in the best idea for motorists. Other published contributions will be paid for at our usual rates.*

Fig. 1. Transposing headlight bulb and feed wire gives light to work on the motor

Headlight Utility

THE socket in many types of auto headlights is a double-ended affair with the bulb plugged into the end inside the headlight and the supply wire from the battery plugged into the other. Such an arrangement permits you to obtain plenty of light for working on either side of the motor with very little trouble. Just remove the headlight rim, take out the bulb, and detach the supply wire. Now plug the bulb where the wire was and put the wire in the end of the socket inside the headlight. You may find it necessary to add a few inches to the length of the wire to make it reach around to the front of the headlight.

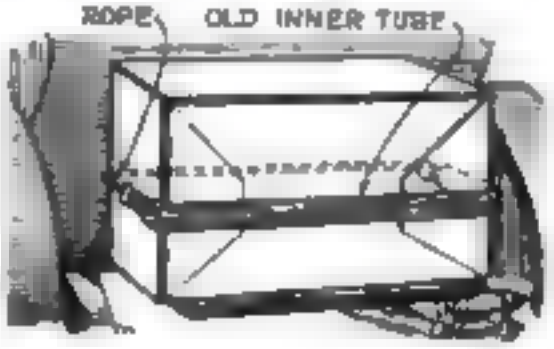


Fig. 2. Elasticity of an old inner tube holds packages tight on the luggage rack

Old Tube Holds Luggage

THE rubber of which inner tubes are made is of the highest grade and consequently, it is still springy and full of life long after it has been made useless as an inner tube by many punctures and blowouts.

Of course, it is easy enough to tie luggage on the back of your car with a piece of rope, but the arrangement shown in Figure 2 is much more handy and convenient, and in addition the elasticity of the rubber will keep the luggage tight so that it will not rattle after a few hard jounces. By making the loop of cord and inner tube somewhat smaller than the smallest package you are likely to carry you will find that any bundle that will go on the luggage carrier can be held in place.

A Wheel Puller

SOME iron bars, a couple of heavy bolts and a piece of copper can be made up into a puller that will serve to remove the rear wheels of any car if the wheels are fitted on the end of tapered axles. Figure 3 shows the construction and the dimensions of the iron bars. The copper plate should be riveted to the bar as shown to prevent injury to the end of the axle. After the bolts are set up tightly, the outside bar should be struck with a heavy hammer on the center over the end of the axle. This arrangement is particularly useful to the service man who may be called on to remove the wheels of cars of old style with old wood hub cap threads. This puller transmits the strain through the spokes to the hub of the wheel

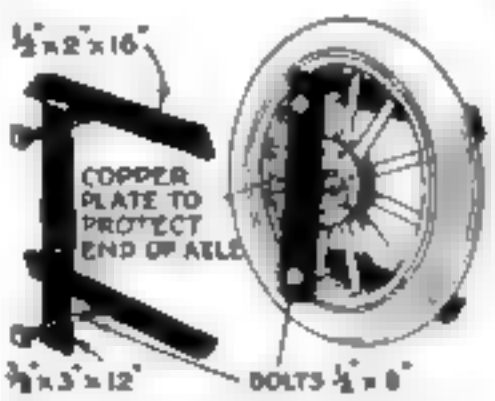


Fig. 3. Wheel puller made of iron bars, a piece of copper plate and two heavy bolts

Protection Against Thieves

NOTHING is more disconcerting to an auto thief than a noise which will call attention to his activities, and so the simple wiring scheme shown in Figure 4 should prove quite effective while the car is left in a well populated district. All you need is a single pole, single throw knife switch and a few feet of wire. The knife switch should be concealed at any convenient point behind the instrument board. Connect one terminal of the switch to the binding post on the ignition switch or to the wire that runs from the ignition switch to the spark coil, at any convenient point. Connect the remaining terminal of the switch to the binding post on the horn that is wired to the horn button, or to the wire itself if that is easier. When the switch is closed, turning on the ignition will cause the horn to sound.

Wire Loop Holds Screw

IT ALWAYS is easy enough to remove a screw from an inaccessible place provided you can get at it with the screw driver, but it is not so easy to replace the screw where it belongs after the job is finished. Often there is not sufficient space to hold the screw with the fingers or a pair of pliers. In such cases the job can be accomplished very easily by using a piece of fine wire as shown in Fig. 5. After the screw is started in the thread, the wire can be pulled off. A single strand from a piece of drop cord or ignition cable will serve for small screws. A light wire is best, as it can be pulled off easier after the screw is started in the hole.

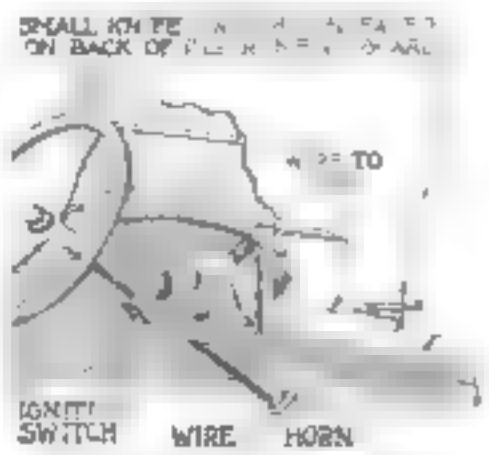


Fig. 4. Turning on ignition switch starts the horn sounding continuously, foiling the automobile thief

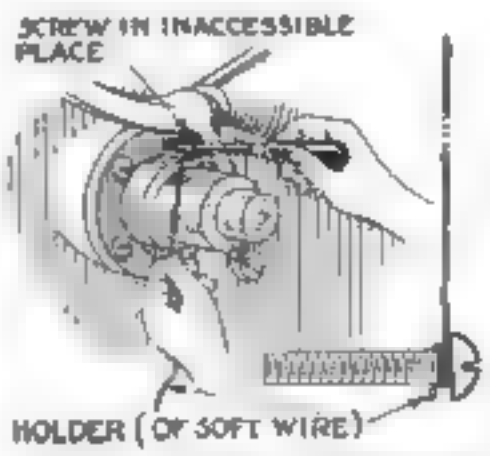


Fig. 5. Removing inaccessible screws is easy with a small piece of wire, as is replacing them afterward

Some *Fine* Points *of Valve* Grinding

Gus Explains a Few Tricks to Motorist Who "Knew How," but Ruined an Easy Job

By MARTIN BUNN

"You're certainly ground 'em aplenty," Gus observed. "The valves and seats are worn down as much as they would be after ten normal grindings"

LATE one afternoon, just before closing time, a customer bustled into the combination salesroom and office of the Model Garage.

"Got any good valve-grinding paste?" he demanded. "I want the kind that has two compartments—one with coarse compound and the other with fine."

"I'm sorry, Mr. Rankin," replied Joe Clark, "but we don't carry that kind. Why don't you try the new water-floated paste? Gus Wilson, my partner, says it does a dandy job."

"Nope!" Rankin growled. "No substitutes for me! I know what I want." And he left the office.

Gus Wilson, who was working on a car near by had overheard the conversation. "We never seem to have what that pest thinks he wants," he called out to Joe. "I wouldn't shed any tears if he never came near this place again. But I have a hunch he's going to need us to get him out of trouble one of these days."

"He won't get into trouble this time," laughed Joe. "Valve grinding isn't so hard."

"Huh!" snorted the veteran auto mechanic. "Don't fool yourself. Valve grinding looks easy and it is easy, but you can make plenty of mistakes if you don't know how to go about it."

Two weeks later the phone rang insistently and Joe clamped the receiver to his ear. A moment later he turned from the phone with a grin.

"Get out the wagon, Gus," he called. "Your hunch came true. Rankin's stuck at the bottom of Marley Hill."

Gus drove off in the service car and in half an hour he returned with the disabled machine on his towrope.

"Now let's see what's the matter with those valves, Mr. Rankin," said Gus as he set to work removing the cylinder head after opening the radiator drain cock.

"See here," snapped Rankin. "I'll admit the car is on the blink but there can't be anything wrong with the valves. Why, I ground 'em myself just a little while ago."

Gus disconnected the hose connections and removed the cylinder head. Rankin leaned over to look at the valves.

All the exhaust valves appeared badly burned. Several were so warped that they made contact with their seats only at one side. The intake valves, on the other hand, were in good shape.

"Those valves must be defective," Rankin stormed. "I'll make the company replace every one of them!"

"Not a chance," said Gus calmly. "It's entirely your fault. You put the intake valves in where the exhaust valves ought to be, and the exhaust valves are doing intake duty."

"I did it on purpose," Rankin admitted. "The exhaust valves looked blackened, and they were pitted, so I thought I ought to shift them around—to equalize the wear."

"That's where you went wrong," explained Gus. "A lot of cars these days have plain steel valves for the intake and special exhaust valves that can stand a lot of heat without warping. The manufacturers have to save every penny in order to sell cars at today's prices—so there's really nothing to criticize. The intake valves have an easy time of it compared with the exhaust valves that are burned with hot gas on every explosion."

GUS removed the valves and the result was quite evident. Both the surfaces of the valves and the faces of the seats were blackened and corroded.

"How many times have you ground these valves?" asked Gus.

"This is the second time," Rankin answered. "The first time I put the valves back as they were."

"You certainly ground 'em aplenty," Gus observed. "These valves and seats are worn down as much as they would be after ten normal grindings. It isn't necessary to grind so much. You used the coarse grinding paste quite a while before you started to finish them. The more you grind the more you widen out the seat—and a wide seat at last. A narrow seat is better, because there isn't so much chance for particles of carbon to jam in between the valve and the face of the seat and keep the valve from closing."

Gus held up a valve. "See that ridge? You've ground the valve against the seat so much that the face is worn away, and there's a ridge around the outside edge. If the valve stem is the least bit loose in the valve guide, that edge is going to catch on the valve seat and prevent it from closing gas-tight. The same thing would occur after a number of correct grindings unless you had the valves refaced.

"This valve shows another trouble. The grinding has made the face curved instead of flat. Looks as if the valve guide is loose and the stem wobbled in

Gus says—

"ANYONE can do a good job of valve grinding, but you can't be careless. Each valve must be gas-tight or it will soon be badly burned. First get the valves clean—especially the stems. Then grind them with the right kind of paste. Press lightly and never turn them round and round.

"Be careful not to get any paste in the cylinders. Wipe it all off after grinding each valve. Replace the intake valve guides if loose. No motor runs smoothly at low speeds if the guides let excess air into the mixture. And setting the clearance between valve stem and tappet with care will help get accurate timing and a quiet motor."

the guide while you were doing the grinding.

"We've got an electric valve-facing outfit and I'm going to grind the faces of all the valves. That will make them practically as good as new. Also I'm going to ream out the gas passages a trifle, to narrow the seats, so I can true 'em up without making 'em any wider, and replace one of the valve guides.

"Holy smoke!" gasped Rankin. "I must be some mechanic! If ever I try grinding valves again" —

"I'M NOT trying to scare you out of working on your car," smiled Gus. "There's no reason why you shouldn't do ordinary valve grinding—if you go about it right. It isn't necessary to grind the valves on a special machine and reface the seats every time. Such treatment is only needed after a number of regular jobs.

"Valve grinding should be done every time you scrape out the carbon. Don't let it go until the valves leak so bad the motor begins to lose compression and runs rotten. Once the hot gases begin to get past them, the valves burn and get much more rapidly. Little and often is the rule for best results. Each time you grind the valves, take off just enough metal so that they seat all the way round; and don't forget to scrape the carbon off the face of the valve before you start grinding.

"Apply the paste evenly, don't press hard and never rotate the valve all the way around. Turn it back and forth through a part of a circle a few times. Then lift it off the seat, turn it part way round and do a little more grinding."

"How do you know when the job is finished?" Rankin inquired. "I ground 'em a lot just to be on the safe side."

"A GOOD mechanic can tell by the feel of the valve and the look of the seat," Gus replied. "If you're very fussy you can buy a pressure tester like this one." He fished an instrument out of his tool kit. It was shaped like an inverted cup with a gage attached to one side and a rubber bulb connected to it with rubber tubing.

"You press the cup over the valve and squeeze the bulb to pump up a bit of pressure," Gus explained. "If the gage needle stands still, you can be sure that no air is leaking through the valve and it will be gas-tight.

"Here's another simple way to test valves. Wipe off all the grinding paste from both the valve and the seat. Rub enough Prussian blue on the ground part to color it and press it tightly in its seat without turning it. Take the valve out again and if you find a complete ring of blue on the valve seat you may be sure the valve is sufficiently gas-tight."

"Maybe I used the wrong kind of grinding paste," Rankin suggested. "The coarse stuff cut fast enough; but it made deep rings in the metal and I had to grind quite a while with the fine paste to get rid of those rings."

"Joe tried to sell you the right kind of grinding paste, but you wouldn't listen to him," Gus reminded him. "You didn't bother to polish the stems, did you?"

"No," Rankin admitted. "I thought the guide would scrape off the carbon if it got too thick."

Neglecting that point is what spoils a lot of amateur valve-grinding jobs," Gus asserted. "The carbon gets burned on the stems of the exhaust valves so hard that it forms a little ring on the stem just where it interferes with the valve's closing tightly on the seat. First the motor begins to miss when it's idling; finally it gets so bad that the motor will only fire on all cylinders when the throttle is nearly wide open and the compression is high enough to jam the valves shut in spite of the carbon-caked stems.

"The funny thing is that the valves seem to close all right and the compression is fairly good when you crank the motor over by hand. The valve stems cool off when the motor is stopped and they contract enough to work right.

"After grinding valves you've got to adjust them for proper clearance. If you get 'em too close, the valves won't seat right, the motor may start hard and the valves will need grinding again too soon.

"Of course, reducing the clearance between the valve stems and the tappets will make a motor sound nice and quiet, especially if the parts are badly worn.

"On the other hand, if there is too much clearance the motor will be noisy. It's better, though, to have them a little too loose than a little too tight."

"What's the correct clearance?" Rankin asked.

"Depends on the car," replied Gus. "The service instruction book will tell you what the clearance should be. If you haven't got a book, set the intake valves with about three thousandths of an inch clearance and the exhaust valves at five thousandths—exhaust valves always need more because they get hotter and the stems expand to a greater length. If it's an overhead valve motor the clearance should be greater—about five to seven thousandths for the intake valves and from seven to ten thousandths for the exhaust.

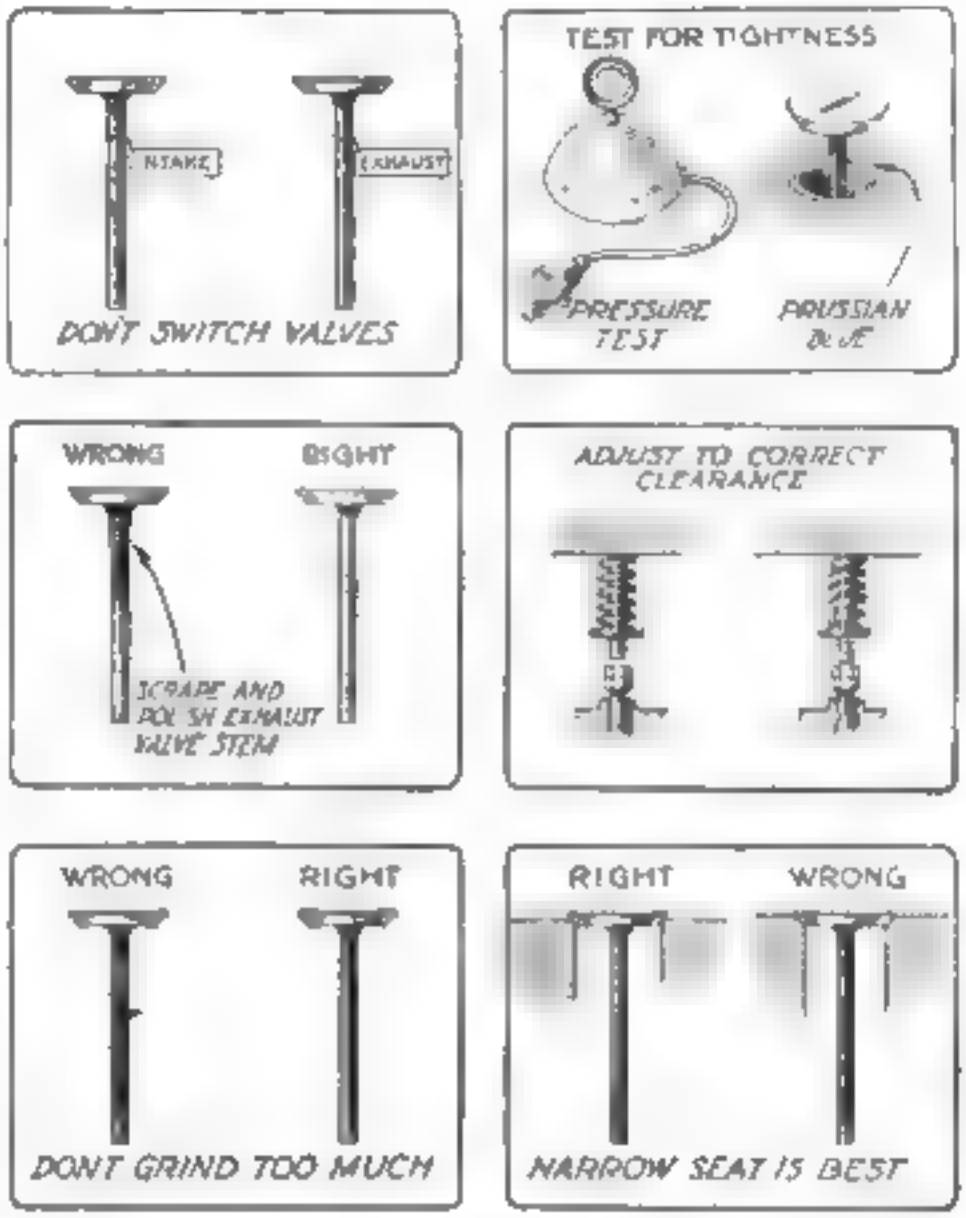
"WHATEVER clearance you use, it's mighty important to have all the intake valves exactly the same, the exhaust valves also should be alike. Then whatever noise is made by the valve mechanism will be smooth and steady. If one valve is a trifle looser than the others you are sure to hear the individual click."

"One other question I'd like to ask," said Rankin. "I've been turning the motor over by hand to find when the valve is closed so I can set the clearance. As soon as I see that the valve's closed I get busy with the adjusting nuts. Is that right?"

"Not quite," Gus answered. "Turn the motor one half a revolution beyond the point where the valve closes. That is especially important in a motor that has been driven considerably, because when the valve closes the valve tappet snaps down on the cam just past the high part that makes the valve open. This pounding has a tendency to wear the cam at that point and if you do your adjusting while the tappet is resting on the worn spot, there won't be enough clearance on the rest of the low part of the cam.

"Don't forget to inspect the valve springs. Weak springs make the motor run rotten at high speed. The trouble is that a weak spring doesn't close the valve fast enough, so that it stays open when it should be closed. The faster you go the worse the valves work. Of course it is easy to test the spring for weakness, because a weak spring always is shorter than a new one. So just compare your springs with a new one, and discard any that are noticeably short."

"Well, if I do a bum job the next time I grind the valves it won't be your fault," said Rankin as Gus finished his explanation, "and if you folks told me that breakfast food made good valve-grinding compound, I'd almost believe you!"



The drawings show how and how not to treat valves if you wish to have a smooth and even running engine. Reading down, the first column shows valves that must not be switched, unpolished and properly polished stems and wrongly and rightly ground valves. The second column shows tests for tightness, clearance adjustments, and proper and improper seats

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STANLEY TOOLS

This seal on a radio, tool or oil burner advertisement signifies the approval of the INSTITUTE OF STANDARDS. See page 6.

New Ways *to Paint* Furniture

Five Distinctive Methods of Decorating a Magazine Rack Color Schemes Stippling Transfers

By BERTON ELLIOT

MOST popular of all the unpainted furniture novelties now being widely sold for finishing and decorating at home is the magazine rack.

The reason is easy to see. It is highly decorative and, when gracefully designed, has a charm of its own. It is useful, for there is hardly a household, in this magazine reading age, that does not have a number of magazines about all the time. It is reasonable in price. It looks well anywhere. And it is a simple thing to decorate, one of the easiest for the amateur painter to start with. So its popularity seems to be deserved.

The possibilities for decorating a magazine rack are almost unlimited, when one considers the wide range of colors, shades and tones, the many transfer designs available, and the different types of treatment that may be employed. It may be readily decorated to harmonize with any color scheme.

For those who have not attempted the decoration of furniture, a magazine rack is a good piece upon which to make a beginning. The work is certain to turn out well, if the following suggestions are observed, and then the methods so pleasantly learned in this way may be used to decorate larger pieces.

Five typical schemes of decoration are illustrated. These may be carried out in any colors desired. The color schemes reproduced are attractive combinations; others are suggested in the following paragraphs, which describe in detail each of the five methods of treatment.

1. Plain color

2. Color blend

3. Color print

4. Stipple and transfer

5. Border and transfer

1 Plain color effect with another color on the edges and a floral transfer decoration. Almost any body color may be appropriately used. Gold is an especially suitable color for trimming, as it harmonizes with most body colors and adds a desirable touch of richness. Lettuce green body color and gold trim, for example, is a pleasing combination. In transfer designs the popular motifs are flowers, slops and birds.

2 Blended effect radiating from very light at the top to dark at the bottom. Black stippled over green, black over Chinese red, gold over green, gold over black, and gold over red are all good.

3. Plain color effect, decorated with a color print from a magazine, and the entire surface, including the design, coated with clear lacquer. A liquid preparation is now available by means of which printed designs from magazines, newspapers and wall papers may be transferred to any surface. When this method is used, it is not necessary to coat over with clear lacquer unless desired.

4. Stippled effect, blending from dark at the edges to very light at the center. The foundation coating is brushed on as for a plain color effect. The stipple color is applied with an air brush or by pouncing on with a stencil brush (see page 113). A panel of the foundation color is left in the center for the transfer. Lettuce green foundation color, stippled with black and with gold edges and Colonial design transfer, would be a rich and dignified treatment.

5 An oriental effect. The body color—black, for example—is carried to within 1 inch of the edge, the border

(Continued on page 113)

How *to Build* a B-Eliminator

Your Choice of Two Practical Designs—A Standard Type or a De Luxe Model for Exceptional Results

By ALFRED P. LANE

THERE are two ways in which you can go about the problem of building a B-battery eliminator. One is to follow standard practice and assemble an outfit according to the arrangement shown in Figs. 1 and 2. This is the circuit used in the majority of factory built eliminators and if you use parts of high grade, your eliminator will be just as good electrically as the commercial product. There will be a slight saving in expense.

The other way is to use a more elaborate circuit arrangement and more expensive apparatus to construct a de luxe B-eliminator. This procedure will appeal to you if you are willing to spend slightly more than the cost of the high grade commercial eliminator in order to obtain extraordinarily perfect results. A de luxe type of B-eliminator is shown in Figs. 3 and 4.

Both these eliminators have been carefully tested by the Popular Science Institute of Standards and the results of these tests are shown in graphic form in Fig. 5.

The quality of any B-eliminator is measured by how nearly it comes to supplying perfectly smooth direct current and by its ability to maintain a constant voltage, regardless of the amount of current drawn from it or the fluctuations in the voltage of the electric light current that is used to operate it.

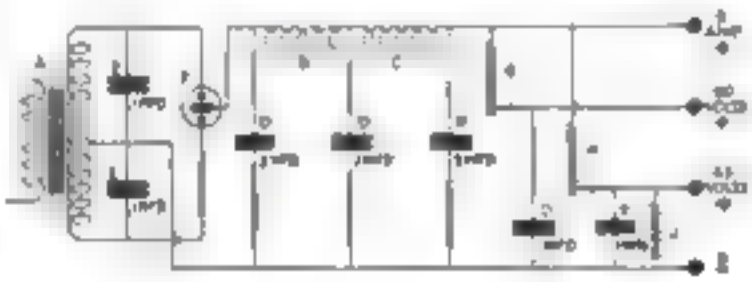
IF THE pulsations are not removed from the current by the time it goes from the binding posts of the eliminator, a certain amount of hum will be produced in the loudspeaker, and a measure of the severity of this hum is the amount of alternating voltage left in the direct current.

Inability to hold the voltage steady means that adjustments must be provided so that you can regulate the voltage to suit the current requirements of the individual receiver to which the eliminator is connected. Variations in voltage also show up in poor quality when you attempt to operate the receiver at close to maximum volume.

Testing the de luxe B battery eliminator on the Popular Science Monthly 5 tube receiver—a good combination

The curves marked "standard" eliminator in Fig. 5 show the performance of the B-eliminator illustrated in Figs. 1 and 2. High grade commercial eliminators give about the same results. And any eliminator that tests out as well as this will give good results on almost any type of radio receiver except, perhaps, those using resistance-coupled audio amplification.

If you want still better performance, you can get it by building the eliminator shown in Figs. 3 and 4 and which in the Popular Science Institute of Standards tests produced the curves marked "de luxe" in Fig. 5. Note that the voltage regulation is exceptional. In fact the de luxe eliminator gives better results in this respect than can be obtained from dry cell B-batteries unless they are absolutely new. The hum as indicated by the alternating current voltage still remaining in the output of the eliminator has been reduced to an extremely low figure.



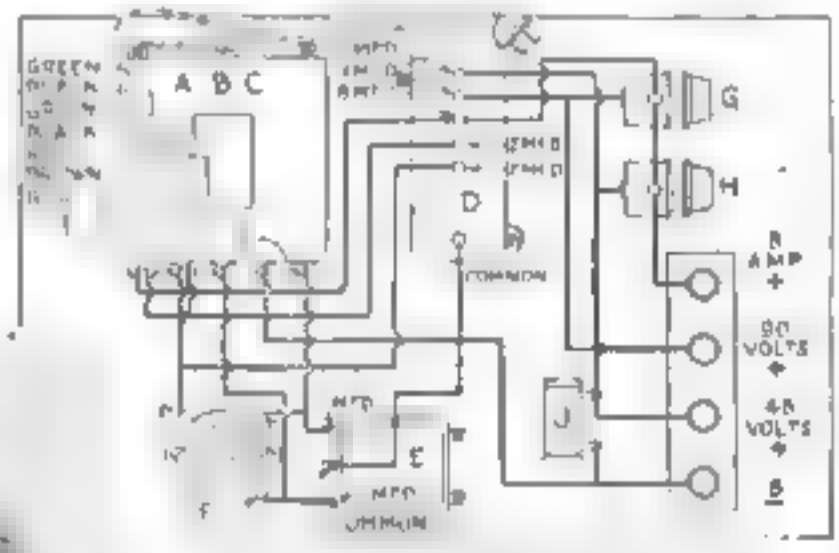


Fig. 1. Picture wiring diagram of the standard eliminator, with the theoretical wiring diagram at the left of it. Cases ABC, D and E should be grounded to the minus B wire at any point. The grounding wires have been left out purposely to simplify the diagram

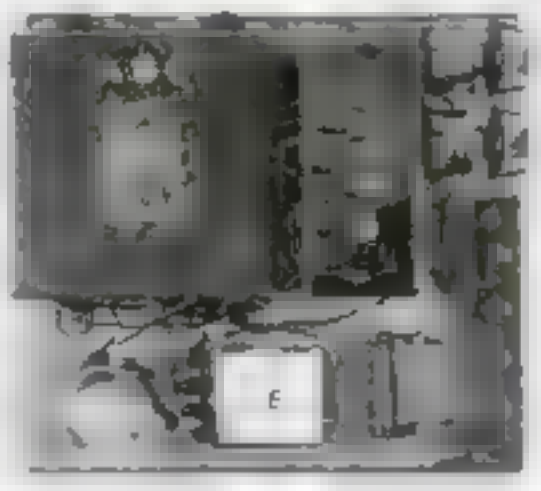


Fig. 2. Two views of the assembled B-eliminator. G controls the voltage on the 90-volt binding post and H controls the detector voltage. Check your wiring several times before you turn on the current

Additional tests were made to determine the effect of using the de luxe eliminator under conditions where the voltage of the electric current was not steady. A current of 42 milliamperes was drawn from the eliminator which represents the amount consumed by a 6- or 7-tube set equipped with power tube. When the electric light line voltage was 117, the voltage developed by the eliminator was 197.5 volts. Reducing the line voltage to 94 caused the output voltage to drop to 179 volts. In other words, a change in the line voltage of 23 only changed the output 16.5 volts. A stand-

ard type of eliminator would show a far greater falling off in output voltage under the same conditions.

To sum up the relative advantages of the two types of eliminator, the standard arrangement shows you how to build the simplest and cheapest eliminator that will give good results. The de luxe type represents a higher class instrument that costs more to build but that gives less hum, a practically constant voltage output, and complete freedom from adjustments of any kind. It will operate perfectly regardless of the type of set or its current consumption. Obviously it would be foolish to build the de luxe type of eliminator to use with any set of less than five tubes with a power tube of the 171 type in the last audio stage.

WHILE it is possible to get C-voltages out of a B-eliminator, troubles and complications develop in many cases. Such an eliminator is more costly to build and the extra expense is not worth while, especially as a 45-volt battery used to supply the C-voltage required by the 171 tube will last for well over a year.

The list of apparatus needed to build the standard type eliminator in Figs. 1 and 2 is as follows:

A, B, C—Power unit consisting of high voltage transformer and two choke coils.

D—Filter condenser block having terminals giving 2, 2, 8, 1 and 1 mfd. variable capacity, rated at not less than 150 volts D. C. working voltage.

E—Buffer condenser having two terminals giving 1 mfd. on each, rated at not less than 300 volts A. C. working voltage.

F—Standard X-type socket.

G and H—Variable high resistances, graduated wire-wound type.

J—Fixed resistance 10,000 ohms.

Type H filamentless rectifier tube, 60 mil. rating.

Four binding posts and wooden baseboard.

It makes no difference whether you buy A, B, C as a single unit in one case or as separate units. Results will be the same. The combined unit is more compact, of course.

The exact wiring arrangements will depend on the individual units you purchase. Fig. 1 shows the arrangement of the wiring of the model eliminator.

To build the de luxe eliminator you will need the following apparatus:

A¹—High voltage transformer with center tap giving 350 volts each side of zero. It is desirable to get one having a filament winding also, a use for which will be shown in an article in next month's issue.

B¹ and C¹—Choke coils developing not less than 30 henrys inductance at a 50 mil. load.

D¹—Filter condenser block having terminals giving 2, 2, 4, 4, 1 and 1 mfd. variable capacity, rated at not less than 750 volts D. C. working voltage.

E¹—Buffer condenser giving 1 mfd. on each of two terminals, rated at not less than 400 volts A. C. working voltage.

F, K and L—Standard X-type sockets.

M—Fixed resistance 13,000 ohms with tap so that you can divide the resistance into sections of 5000 and 8000 ohms.

One type BH filamentless rectifier tube, 85 mil. rating, and two UX874 voltage regulator tubes.

Four binding posts and baseboard.

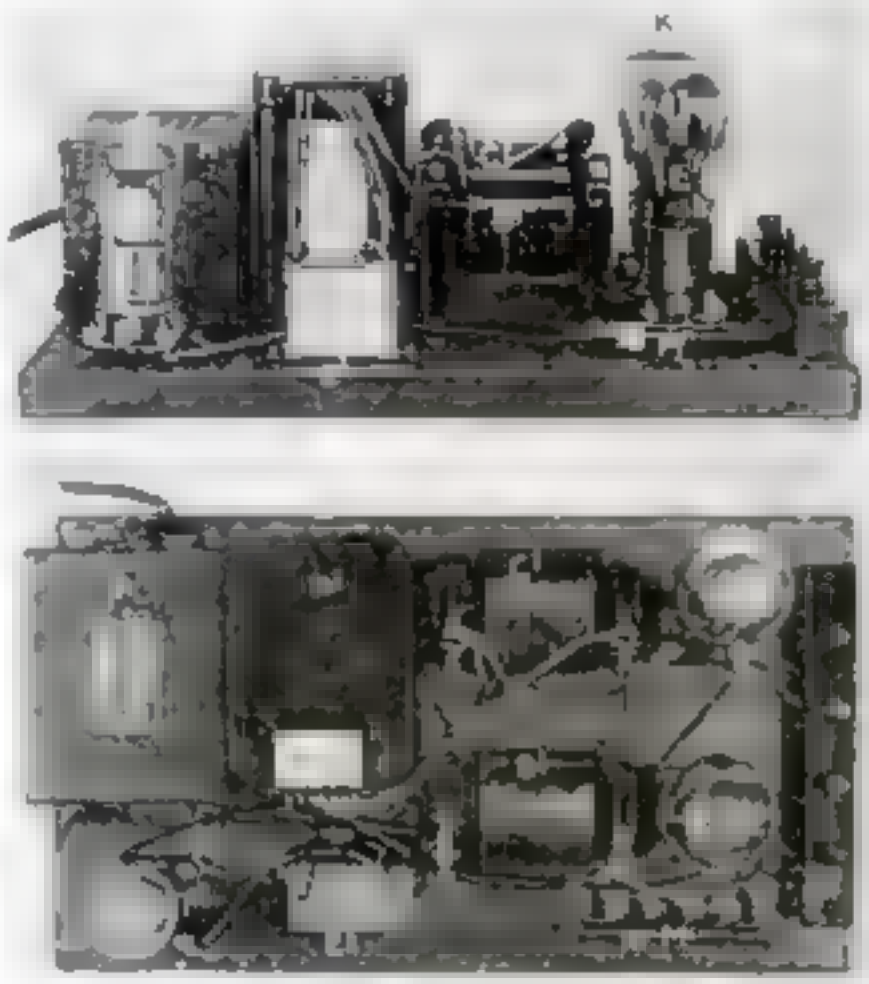


Fig. 3. This de luxe type of B-battery eliminator has no adjustments. The output voltage is automatically regulated

All apparatus must be exactly as specified in order to obtain the results shown in curves of Fig. 5. In fact, the extremely small hum produced by this eliminator as compared with the standard type lies chiefly in the extraordinarily effective choke coils B¹ and C¹. The excellent output voltage regulation is obtained by developing more power than is required and allowing the excess current to flow through the voltage regulator tubes placed in sockets K and L. By this method of operation, the eliminator always is working under a constant load and the current consumed by the set is subtracted from the amount flowing through the regulator tubes.

Before you start wiring, study Figs. 3 and 4 and be sure that you understand every detail. Note that the parts should be assembled on the baseboard essentially as shown with at least two inches of space between the choke coils B¹ and C¹. You are dealing with relatively high voltages, so be sure to use rubber or enameled fabric insulated wire throughout.

Note that only two terminals are used on sockets K and L, the G terminal and the diagonally opposite filament terminal.

Either type of eliminator will give ample current output to operate at maximum the largest set with a 171 type power tube in the last stage of audio amplification. Use the filamentless type H 60 mil. rectifier tube in socket F of the standard type eliminator. Use an 85 mil. type BH filamentless rectifier in socket F¹ of the de luxe type with the UX874 voltage regulator tubes in socket K and L.

To put the standard type eliminator into operation, connect the binding posts to the similarly marked ones on your radio set, turn on the filament switch of the set, plug the eliminator cord into the light socket and adjust the knobs of variable resistances G and H for best reception results. Always turn the eliminator on after you have turned on the set, and turn off the eliminator before you snap the filament switch on the set. If you don't follow this procedure, excess strain is placed on the filter condensers in the eliminator. Of course, if you use an automatic relay

(Continued on page 107)

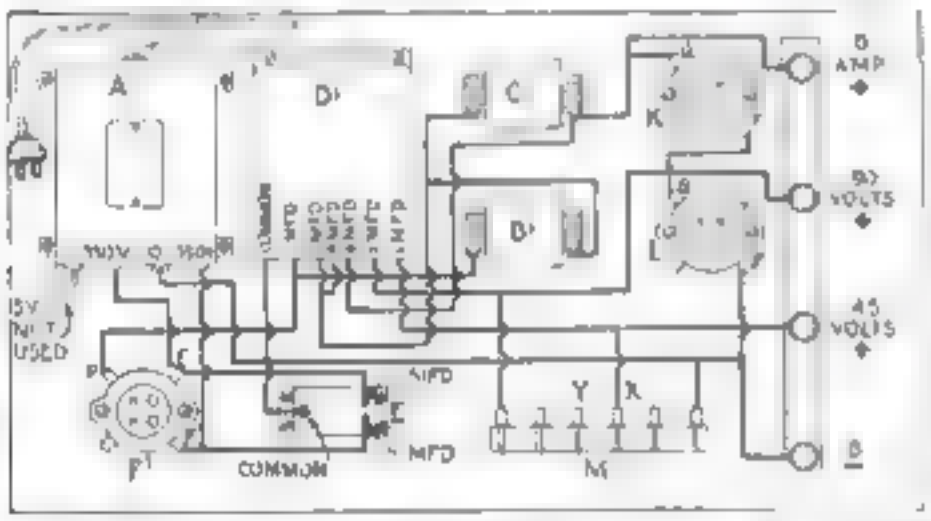


Fig. 4. How to wire the de luxe model. The theoretical wiring diagram is at the right of the diagram above. Be sure to ground the frames of A, B, C, D and E, although the grounding wires have been left out to avoid confusion. Wire to point X as shown for a 200A detector tube but connect to point Y if higher detector voltage is required.

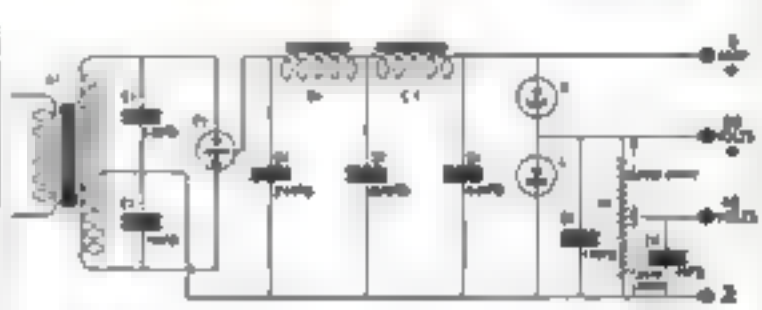
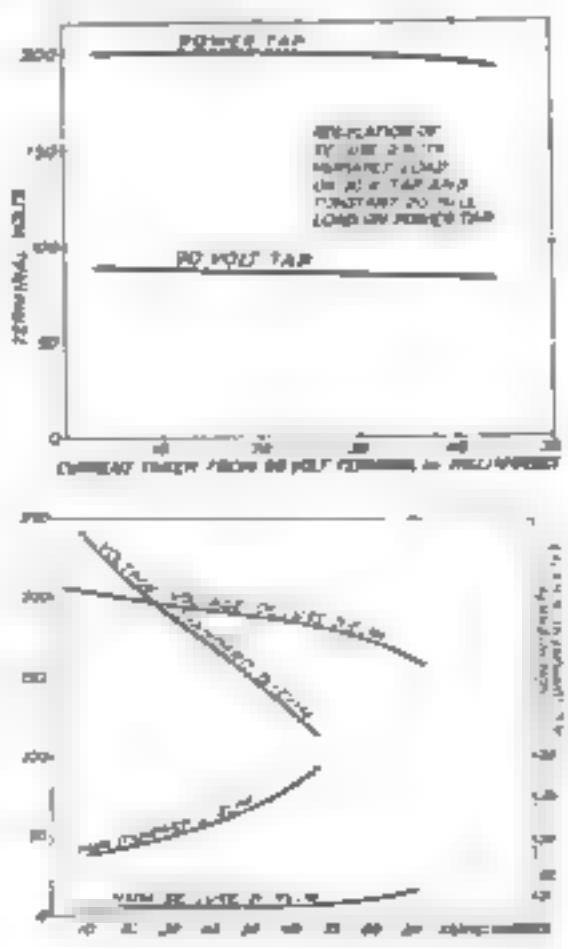


Fig. 5. In the upper section of the diagram below is shown the accurate voltage regulation of the de luxe type of eliminator under actual working conditions. Both standard and de luxe type of eliminator are graphically compared in lower section of the diagram.

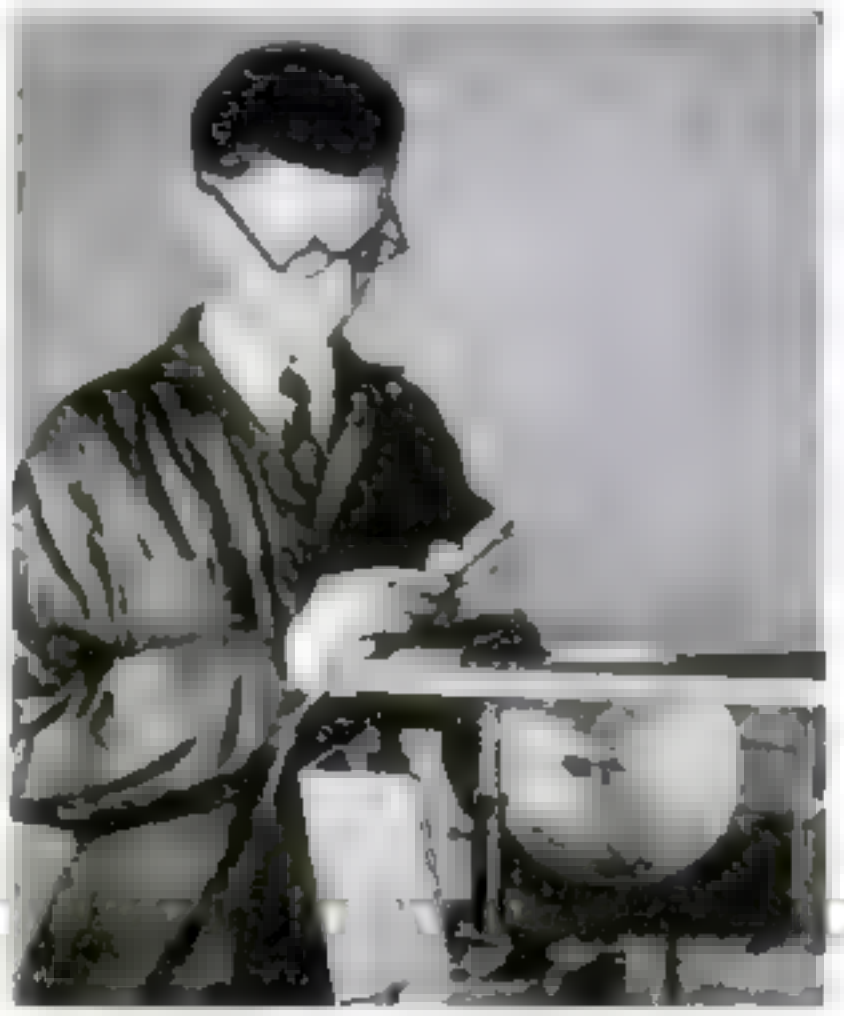


My *Motorized* Shop Cost $20

How an Ordinary Polishing Head Was Developed into an Outfit for Sawing, Turning, Grinding, Drilling and Sanding

By WALTER E. BURTON

The saw table has both a ripping and an adjustable crosscut guide



Side view of the saw table with the dust chute in place

A bent iron bar serves as a convenient rest for grinding tools

SPACE and money are two of the things with which the average home mechanic is not always abundantly supplied. These very limitations resulted in the construction of the small but exceedingly versatile and absolutely motor-driven home workshop illustrated.

The machine itself, without tools and accessories but with a new one-quarter-horsepower motor cost less than twenty dollars. It is so compact that it could be placed on a table 3 ft. square, yet it will do rip and crosscut sawing, grooving, grinding, polishing, drilling, sanding and turning.

For the main element of the shop a polishing head of fairly heavy construction, costing between four and five dollars, is used. The motor may be of almost any type, provided it has sufficient power and a speed of about 1750 revolutions a minute. A new one, rated at one quarter horsepower, may be purchased for about twelve dollars. A circular saw, 8 in. or less in diameter, a 4-in. grinding wheel, an 8-in. polishing disk, about 10 ft. of ¾-in. or 1-in. angle iron, an assortment of pipe fittings, and miscellaneous screws, bolts, and washers, will be needed.

The motor, polishing head and standards

The saw table which is 12 by 10 in., is made from two pieces of ¾-in. wood, one 2 by 10 in., and the other 9½ by 16 in. Angle iron is used to bind the ends to prevent warping. The pieces of wood are spaced about ⅜ in. apart to permit the use of a sliding guide. The larger piece is slotted for the saw blade.

All the parts of the complete motorized workshop except the lathe tool rest

Pipe fittings are used as supports, for several reasons. Nipples of different diameters permit the easy adjustment of the height of the table. The fittings are strong and rigid, and can be drilled and tapped for set screws easily. When the polishing head is used for purposes other than sawing, the nipples may be unscrewed, leaving only the floor plates which will not hamper work.

The floor plates and nipples are placed on the saw table and the supporting table or bench as illustrated. When the grinding wheel is used, the two front upright nipples, together with a piece of bent iron rod form an excellent rest for the work.

It was found best to use as a ripping guide for the saw table a straight piece of wood, held with two iron clamps, because adjusting the table for height causes a slight variation of the position of the saw in the slot. An adjustable sliding guide, made of sheet brass, a set screw and a piece of bar iron or steel is used for mitering.

The lathe bed for supporting the tailstock and tool rest is made of two long pieces of angle iron, spaced with two shorter pieces, the distance between edges of the longer sections being about 2 in.

The tailstock is constructed of ¾-in. pipe fittings, and includes a floor plate, a nipple 2 in. long, and a T. A ½-in. bolt, the end ground to a point, is fixed in the T as

(Continued on page 100)

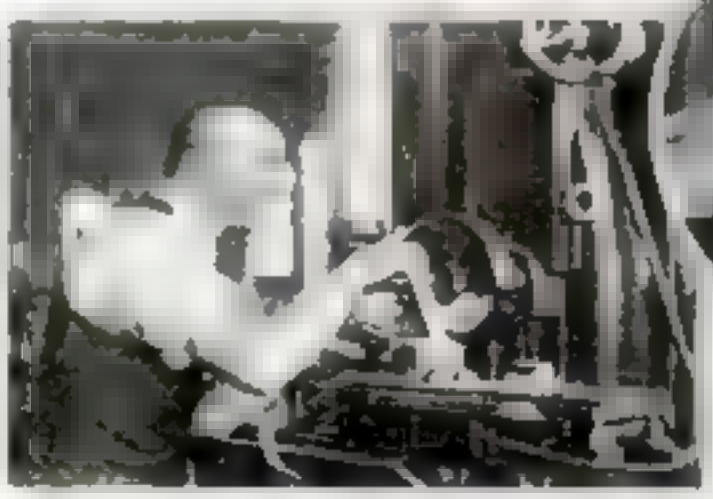
System in Surface Grinding

What Wheels to Use—Set-Ups That Simplify Difficult Jobs

By HECTOR J. CHAMBERLAND

How micrometer depth rods are used to check a dovetail by the roughing-in grinding of a snap gage. A drawing of the gage is reproduced on page 122

The grinding of the gage is completed on the right. This is a typical example of a dovetail surface grinding job



A dial indicator is used to measure the depths in a dovetail forming tool. Drawing the wheel at an acute angle assists

EVERY toolmaker and machinist knows the part played by the surface grinder in toolroom production, and the more experience one has had in using this versatile machine, the better one can appreciate its value.

With a magnetic chuck and a set of indexing centers, which should be its regular equipment, the machine can be relied upon in case of a rush job to execute much work ordinarily done on other grinding machines, should the latter be in use.

As in the case of any grinding machine, the choice of the proper wheel for each operation is an important factor, from the standpoint both of economy and of good work.

The wheels recommended in this and in an article to follow are standard; if wheels of other varieties are preferred, the corresponding grain and grade should be used.

The care of the machine should not be overlooked. The spindle should be tested for wear and end play occasionally and the ways of the carriage kept well lubricated. A daily kerosene bath will save money.

The magnetic chuck should be surfaced off every two weeks by removing .001 in., which is generally sufficient. For this operation a 46-J wheel will give a good finish.

If possible the chuck should never be removed from its position. A convenient scheme that saves much time is to have a plate the size of the chuck to which the centers are fitted. To prevent scratching, thin paper should be used under the plate as well as under any piece to be ground.

Wheels 6 or 7 in. in diameter and from ¼ to ⅜ in. thick are recommended. For ordinary work in grinding tools made of high speed steel it is well to use a wheel one grade softer than that recommended for carbon steel; this is, of course, the general rule in most grinding operations.

The most difficult operations that come within the scope of surface grinding are probably the making of snap gages and dovetail forming tools. These are often more or less complicated, and the average toolmaker, unless familiar with this work, is rather uncertain as to how to proceed.

Grinding a plain snap gage is a common operation, but one like that shown on page 122 requires close attention. This gage has seven dimensions on one side and four on the other, all to be ground within close limits.

These gages are ordinarily made in sets of two or four. The blanks are pinned together and milled as one. In this case it is not advisable to pursue this course in grinding, because, owing to the close limits, a slight variation may occur and in that event it would be far cheaper to scrap one than two or four pieces.

An 80-J wheel of proper diameter and width is recommended for this operation. For safety against breakage, smaller dimensions than ½ in. should be milled with an allowance of .001 in. for sizing to size.

To attain accurate results, the gage should traverse the wheel all the way across, in other words the wheel, having been previously dressed and concaved slightly on both sides, should grind on its own two cutting edges in order to hold both ends of each dimension parallel.

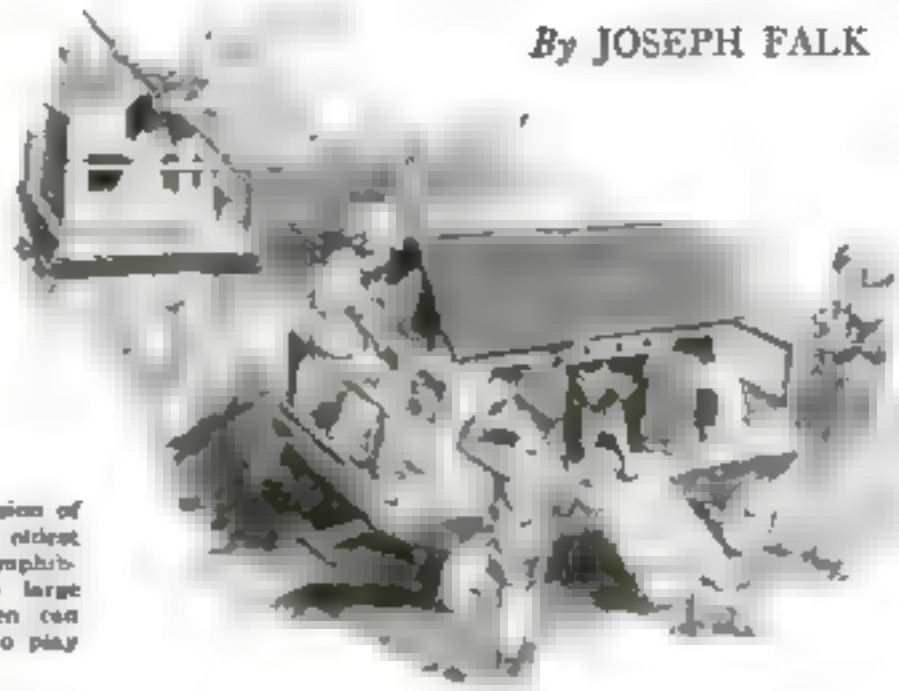
The grinding allowance left in making the blanks is generally from .010 to .012 in. For measuring the steps a micrometer depth gage is used; for the lengths, a telescoping caliper may be used, but in this case, owing to the close limits, the measuring rods, as illustrated in one of the photographs above, are the safest. These are made of ⅛-in. drill rod. They are cut off ¼ in. longer than the finished sizes, slightly

(Continued on page 122)

MANY time-saving shop ideas are contained in the continuation of the Better Shop Methods Department, to be found on pages 116 to 122.

Unique Noah's Ark Toy Floats or Runs on Land

By JOSEPH FALK



Latest version of one of the oldest toys—an amphibian ark so large that children can go aboard to play

HERE is a Noah's ark toy built for use on land or water and large enough for small children to get on board with all their pets and animal toys. It is the latest and most novel development of one of the oldest of toys.

The ark is mounted on a simple home-made truck with wheels set off-center so that it will rock realistically as it is pulled along. Then, if there is a shallow wading pool in the neighborhood, it can be wheeled to the water's edge, removed from the truck by loosening four bolts, and launched like a boat.

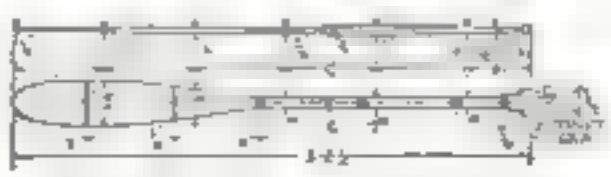
In building a toy for this dual use, it is important, of course, to have the hull water-tight. Use clear, sound cypress or cedar ¾ in. thick for the sidepieces and ½ or ⅝ in. thick for the bottom. The latter should be fitted carefully and the joints coated liberally with white lead as the pieces are fastened in place with 1¼- or 2-in. galvanized boat nails. The hull should be tight after it has been in the water a short time, but if any cracks develop, they can be caulked with candle wicking or strips of cotton set in white lead. The superstructure should be as light in construction as possible.

If there is no water near by safe enough for using the ark as a boat, the children still can have a great deal of fun playing with it. In that case the sidepieces should be so well rounded that when the ark is removed from the truck it can be rocked in teeter-totter fashion. The narrow bottom boards should be at least ⅝ in. thick to withstand the rough treatment.

Obviously, the toy can be made any size, according to the number of children who are to use it and the materials available, although an over-all length of 6 ft. and a width of 2½ or 3 ft. are ample. The design may be modified in many ways to suit the ideas of the builder. The more doors, windows and such accessories as a bird house and gangplank there are, and the brighter the colors in which it is painted, the better the children will like the ark. The toy can be built, too, in a smaller size—2 ft. long or less—with the same advantage that it can be either drawn over the ground or floated on any shallow pond or stream.

A Handmade Paddle for the Canoeist

SOONER or later, many canoeists who take pride in keeping their equipment in the best of condition, are fired with the ambition to make a paddle of their own. A good model to copy is that illustrated. It is patterned after the favorite paddle



Side and edge views of the paddle, which is a favorite style for long trips and rough water

of a famous Canadian guide and is especially desirable for use on lakes and large rivers where rough water is apt to be encountered.

The paddle may be made of Norway pine, spruce, maple, ash or other tough, strong woods. The piece must be straight grained and well seasoned. The length should be the same as the height of the one who is to use the paddle. Work from the center lines and do the shaping with saw, ax, drawshave and spokeshave. Scrape the wood and rub smooth with a fine grade of sandpaper or steel wool. Finish with linseed oil.—C. A. L.

AFTER I HAD done a careful job of white enameling the interior of our refrigerator it was allowed to dry thoroughly and well aired. When it was put into use, however, the smell of paint spoiled some of the food. I was told to paint the interior with melted paraffin and then scrub it out with hot water and washing soda. This was tried and removed the odor completely.—FREDERICK J. FRASE.

H A V E A C A M E L

Camel is as good as the sea is wide

BOUNDLESSLY deep is the quality of Camel. Its cool, smooth smoke is as tasty and fragrant, as restful and friendly as an ocean plunge. Modern smokers, educated by experience to the quality of tobaccos, have made Camel their favorite. In worktime and playtime, Camel is the most loyal smoking companion anyone ever had.

The choicest Turkish and Domestic tobaccos tell in the smoking. Expert blending has its part in making Camel the finished masterpiece of cigarettes. In creating Camels no cost or care is too great to make them the fittest and finest, regardless of price.

If you don't yet know Camels, you are invited to complete taste satisfaction. Camel is the smoking friend that will never fail you. It's first in this modern, particular age.

"Have a Camel!"

R. J. REYNOLDS TOBACCO COMPANY, WINSTON-SALEM, N. C.

Borrowing fire from Della Robbia

MASTERS of Art they were. Masters of enameling on clay. Their gems of modeling covered with brilliant colors are unequaled today. And the gifted craftsmen of Venice and Limoges have left us superb proof of their ability to apply enamel to metal.

That enamel can be something besides ornamental, that it can actually be useful, is a discovery and a development of this age of machinery and engineering. Step by step the art has become a science. Better metal, better glazes, better methods, and better heat—electric heat.

The glowing units of the electric furnace give a heat that is perfectly uniform and constant—vital factors if the enamel is to be smooth. And in the electric furnace there is no smoke to mar the glistening surface.

Such stories are legion. With electric heat as an ally, manufacturers offer us today hundreds of well-finished products. Even an army of men using Della Robbia's methods could not do this work at any cost.

General Electric engineers have applied electric heating to processes used for bathtubs and jewelry, for cast iron and bread, for tool steel and glue pots. In the G-E booklet entitled "Electric Heat in Industry" you will get some idea of its range of applications and of the possible value of electric heat to any manufacturing business.

GENERAL ELECTRIC

Simply Built Reading Tables

One has a roomy magazine rack, the other an accessible book trough and a lamp platform of unique design

By KENNETH R. LAVOY

READING tables, which are a necessity in every home, are doubly desirable when they contain in themselves some storage place for books and magazines. Two exceptionally convenient tables of this type are illustrated. One is a graceful end table with a rack for magazines and papers; the other is a book-trough table of unique design, with a special platform for the reading lamp.

Both tables are of simple construction and involve the making of no different joints. They can be built in a relatively short time, at little expense for materials, and finished attractively with one of the new brushing lacquers, which dry quickly and give splendid results.

Complete working drawings for both tables and the full size details necessary for laying out the curves required in the magazine end table are contained in the POPULAR SCIENCE MONTHLY Blueprint No. 68 (see the list on page 109). This sheet will be of considerable help to you if you wish to build either of the tables.

Whitewood, white pine or other easily worked wood should be used, although either table, if preferred, may be made of birch, red gum or other cabinet wood and given a natural finish to match the furniture in the room in which it is to stand.

In making the magazine table, first lay out a pattern for the end on a piece of heavy wrapping paper. The curves may be traced directly from Blueprint No. 68, as they are given full size. Cut out the pattern and use it to mark the outline on two boards ¾ (or ⅝) by 14 by 28 in.

THE quickest method of cutting the curves is, of course, with a band saw, but equally good results may be obtained by using a turning saw. Smooth the edges with spokeshave, file and sandpaper.

Next get out the top, which is ¾ by 18 by 29 in., marking the curved ends directly from the blueprint or from a wrapping paper pattern.

The magazine holder requires 2 sides, ¾ by 8 by 19½ in.; 4 ends, ⅝ by 4⅝ by 8 in.; 1 center, ¾ by 11½ by 19½ in., and 1 bottom, ⅛ by 5 by 19½ in.

The magazine-rack end table. Mr. LaVoy is sandpapering the piece before finishing it with lacquer

Plane the boards to the correct dimensions, mark and cut the curves in the center and side pieces, and plane bevels on both edges of the bottom so that it will fit snugly within the side pieces. Fasten the four end pieces of the rack inside the ends of the table with glue and slanting 1¼-in. brads or with 1-in. No. 9 screws. Leave just enough space between each pair of these pieces to receive the center partition snugly. Then fasten the center with glue and nail it strongly from both sides, driving the nails in a slanting direction or toe-nailing, as it is called. The nails are started in the center piece and pass into the ends, so that there is no chance of marring the outer surface of the ends.

Complete the assembly by adding the bottom and side pieces of the magazine holder and fasten on the top by means of S-shaped table top clips or a home-made substitute for them.

Smooth carefully with sandpaper, fill nail holes with plastic wood filler, water putty or glue and fine sawdust, and give three coats of brushing lacquer (see page 79).

The book-trough table is intended especially for the student or book lover who wishes to keep a few books beside his chair. None of the book troughs or tables sold commercially combine the same advantages as this table. Whenever the trough is high and accessible, there is no place for the reading lamp, and in the accepted type of combination book trough and table, there is plenty of room for a lamp, but the books are hidden under the long top. At least, this was my own experience and the reason why I set about constructing a table of the type illustrated.

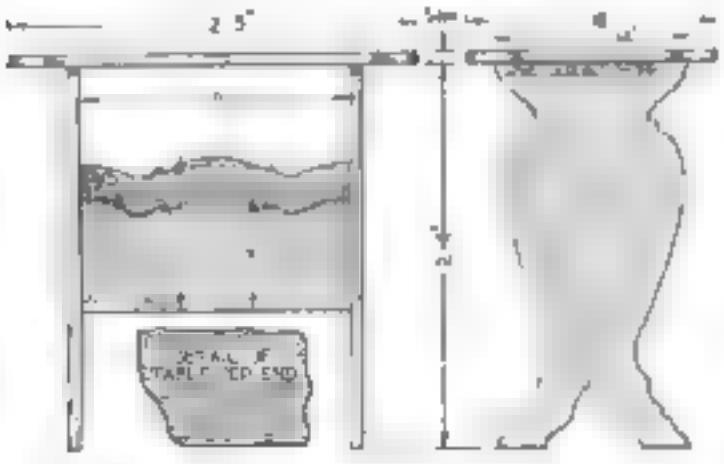
The trough, which is in two parts, will hold twelve books of the average fiction size, and the small platform between them will support an ordinary reading lamp and still leave room for an ash tray. While I did not place a drawer in the table I made for myself, one might easily be added.

WITH the exception of the trough, which is nailed in place, the table is put together with dowels. Screws might be used in places instead of dowels—either round screws with blued heads or common screws with heads set in counterbored holes and concealed with wooden plugs.

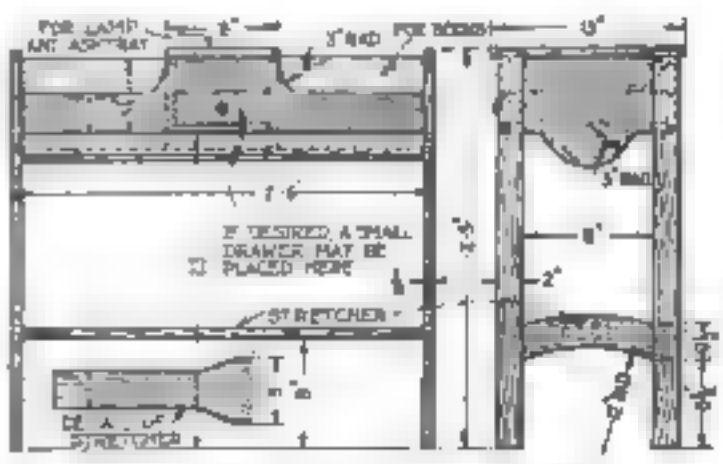
The parts required are 4 legs, ¾ by 2 in. by 2 ft. 5 in.; 2 top rails, ¾ by 3 by 5 in.; 2 rails, ¾ by 3½ by 5 in.; 1 top, ¾ by 8 by 13 in.; 1 stretcher, ¾ by 5 in. by 2 ft. 4½ in.; 2 rails, ¾ by 6 in. by 2 ft. 4½ in.; 2 shelves, ¾ by 5¾ by 10¾ in., and 2 shelves, ¾ by 9½ by 10½ in.

The scale drawings of the table and list of the operations or steps in constructing it are contained on our new blueprint (No. 66, page 103).

The book-trough reading table



Side and end views of the magazine table. All the curves are shown full size on our Blueprint No. 68



Working drawings of the table, which has a trough divided in two by a platform for the reading lamp

What You Can Make of Stone

How to Cut and Polish Decorative Book Ends and Trays—They Cost Nothing for Materials

By W. E. PYKE
Colorado Agricultural College

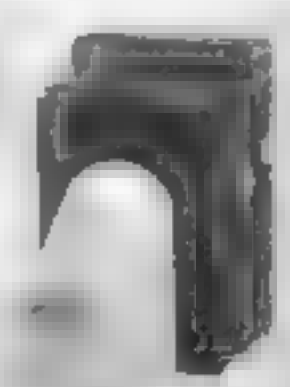
THE home workman usually turns to wood as the material for making small articles. It is quite easy however, to make many useful and unusually decorative articles from stone.

In most communities the raw material is available and needs but a constructive mind and a few simple tools to convert it into beautiful articles for the home.

Ordinary gypsum, especially if it is naturally figured or has been brecciated since its deposition, is easily worked and can be shaped by a novice. Fluorspar, which is used so widely in many industries, is often beautifully banded with exquisite purples, whites and greens. Mexican onyx, which is formed when limestone has been deposited in a cavern, will give effects that are a revelation of beauty, and various chalcedonies, flints, jaspers, and petrified wood can be cut, shaped and polished.

Mr. Pyke cuts the stone roughly to shape with an ordinary hack saw and finishes the work on a grinding wheel

A book end of brecciated gypsum. The polishing brings out the natural beauty of the figured stone



Another unusually decorative stone book end. Simple shapes such as these are the most effective

It is best for the beginner to start with a stone that is soft enough to be shaped roughly with a hack saw. The final shaping can be done with a carborundum wheel.

In choosing a wheel for this work, one should select a small grinding machine upon which the wheels are easily interchangeable so that several degrees of fineness may be obtained.

The wheels, which need not be expensive, can be purchased at almost any hardware store in various shapes and sizes. It is also possible to obtain a polishing brush to fit the grinding head; this will cut down the handwork in the final finishing process.

Pumice and jeweler's rouge, which is finely ground iron oxide, applied by hand or by means of the polishing brush will give the final finish.

Articles that the beginner will find easy to shape are book ends, ash trays and pen trays. The shape chosen in each case should be simple rather than fantastic or unusual. The natural beauty of the stone, which is brought out in the polishing, will further the decorative effect if the raw material has been carefully selected.

Designs for a book end and ash tray

Two designs for book ends are illustrated. These can be executed easily and are especially suitable for the beginner.

It should be remembered that the shaping of stone is much slower on the small scale than woodworking, but it furnishes a desirable outlet of energy in the home workshop, and the reward of the finished article is most gratifying.

WHEN you are trying to open a lower window sash which is badly stuck, remember that you can gain considerable help by making use of the window weights. Pull out both sash cords as far as possible, let go of them simultaneously and push up hard with both hands against the meeting rail of the lower sash. The jerk given by the falling weights will often start the most stubborn sash upward.—L. T. C.

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1500 GOOD TOOLS

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How *to Take Up* Rod Bearings

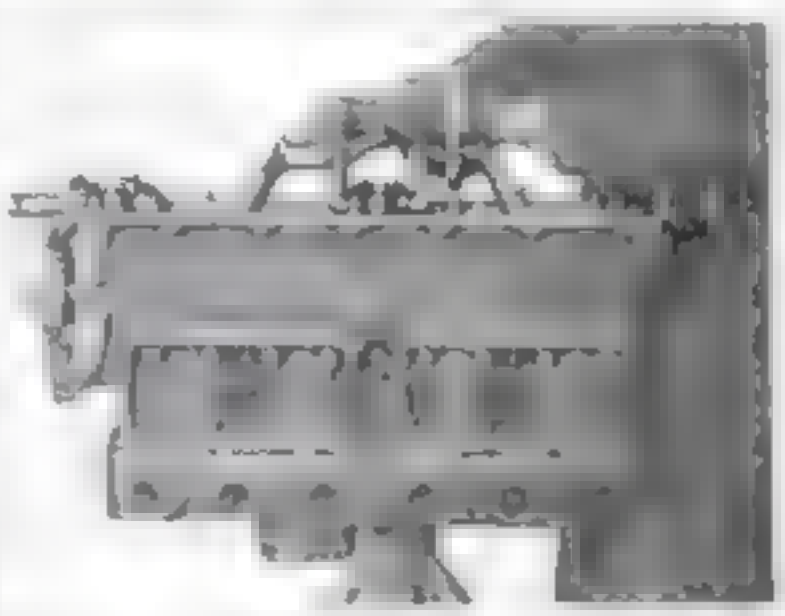
By RAY F. KUNS

Principal, Automotive Trades School, Cincinnati, O

CONNECTING rod bearings will fail more often than any of the other bearings of the motor, speaking in general terms and having in mind no make of motor. This is due to the fact that there is such a great variation in the load they carry and the other conditions under which they give service.

After a great deal of service the connecting rod lower bearings will have worn to such an extent that they may give off slight noises or knocks. The piston serves to pull the bearing first to one side of the crank pin and then to the other side of the crank pin, with the result that each time there is a change in direction and the piston is stopped and started, the play in the bearing allows a slight knock.

Under these circumstances the incipient trouble is remedied by taking up the rod bearings. This is a rather simple task, yet one to be handled carefully. The crank case pan is dropped and then the rod bearing requiring adjustment is located with the throw of the crank for that rod in the down position. The illustration above shows the position for the rod, except that the work is being done in this case with the engine removed from the car.



The cap is removed from the rod bearing a thin shim is taken out on each side and then the cap is replaced

The actual "taking up" operation consists of dropping the cap from the rod bearing by removing the cotter keys and the castellated nuts from the connecting rod bolts. As the cap comes from the rod, watch the shims carefully. There may be a number of these on each bolt or there may be but one; possibly there is none.

MOST adjustments require the taking out of a single shim on each side of the bearing cap. The shims to be removed are the thinnest ones provided, they ought not be more than .001 in thick. If one pair is not sufficient, remove another pair and continue until the rod bearing comes up snug on the shaft. If it should be too tight, replace a pair. The setting up of rod bearings until it is impossible to turn the engine over without great effort is no longer considered the best practice. Oil must be allowed to get into the bearing, yet none can do so until there is clearance. The proper clearance for oil is .001 in. for the splash lubricated bearing and twice that amount for the force fed bearing. These exact limits cannot be obtained in all cases. They are given as the desirable amount and the workman must come as close to them as he can.

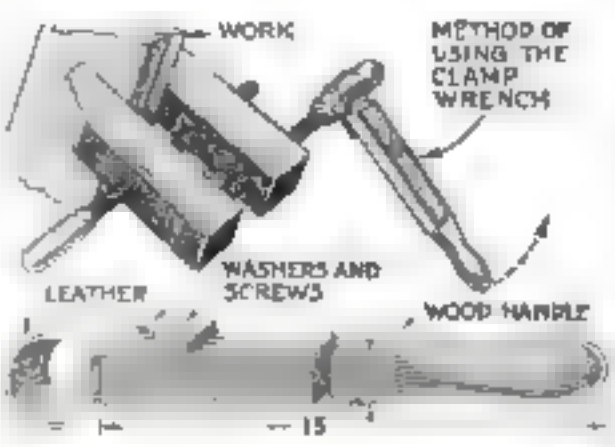
Where no shims are provided, the cap face is dressed off with a file or on a sheet of emery cloth lying on a piece of plate glass.

Do not tighten up on the bearing cap bolts and, if you find that the bearing binds, simply back off the nuts a bit to loosen it and call it a job. It isn't. It is trouble in store. Remove the cap and fit thin shims and then draw the cap down on the shims tight. Shims hold the bearing apart and must be gripped tight between the bearing cap and the rod. Place in new cotter keys, don't use the old ones.

Hints on Using Hand Screws for Woodwork

FEW amateur woodworkers, unless they had the benefit of considerable manual training experience at school make as much use as they might of hand screws, which are especially useful in doing repair work and in gluing up home-made furniture.

To open or close the jaws of a hand screw rapidly, grasp the handles and swing the jaws around and around. When non-adjustable hand screws are used, be sure the jaws are set as nearly parallel as possible, to avoid damaging the screws. A strap wrench made as shown is useful for setting up large hand screws very tight or for loosening a stubborn screw without straining the wrists.—G. A. L.



A simple strap wrench for turning stubborn hand screws especially of the larger sizes

Shelves for a Child's Room

By F. Clarke Hughes

WHAT would delight a small child more than to have for his books and other small belongings a set of hanging shelves which suggest in shape and color a bunny, bird, kitty, clown or fairy? Such shelves are easy to make and form a unique, colorful decoration in the nursery.

Five designs for the end pieces are given in the accompanying illustrations. Other shapes may be devised or copied from toys, and, of course, the size may be whatever the builder chooses.

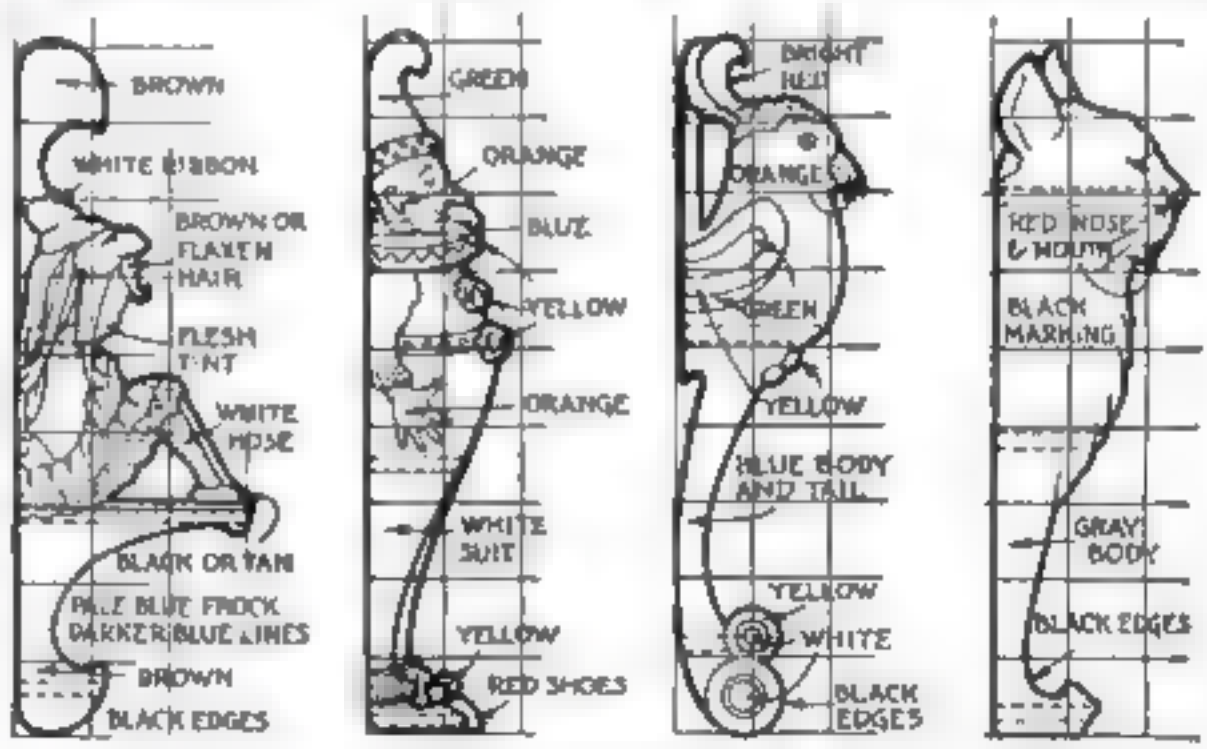
First make a full size drawing of the chosen design on heavy paper and cut it out for use as a pattern. Trace the outline on soft pine or plywood, either ¾ in. or ½ in. thick and cut it out with an ordinary coping saw or a power jig saw if one is available. Smooth the edges carefully with sandpaper.

"Bunny" shelves. A good color scheme is gray for the body with pink in center of ears, red nose and mouth, and black edges

Next lay out the dadoes or grooves which are to receive the shelves and cut them with a chisel. Be sure not to continue the dadoes entirely through to the front edges as they should not show in the finished work. Stop a little back of the front edges and make the shelves exactly as wide as the grooves are long. A quicker but not so workmanlike a job can be done by omitting the grooves and simply nailing shelves in place.

Perhaps the best finish for the shelves is the new brushing lacquer, which can be obtained in many brilliant colors. Suitable color schemes are suggested in the drawings below.

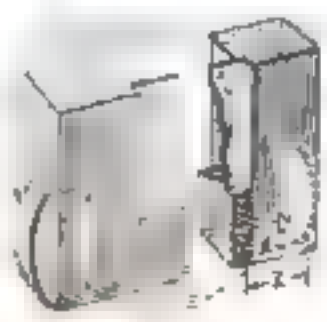
To hang the shelves make two thin metal hangers about ¾ by 1½ in. These are screwed to back edges of the end pieces at top and engage round head screws or small hooks in wall.



Four more attractive end pieces. The squares will aid you in enlarging the design to any extent desired. Suitable dimensions are 18, 24 or 30 in. high with shelves 10, 12 or 14 in. long

Invisible Springs Keep Loose Windows from Rattling

IN THESE days of poorly seasoned lumber, there is always apt to be some window in the house that rattles when raised for purposes of ventilation. The application of concealed springs, as shown, will hold such a window firmly.



Anti-rattlers for sash

The writer cuts 2 pieces of ¾ in. steel strapping, such as is used for binding heavy packing boxes, each 5 in. long. Two holes are drilled or punched toward one end of each piece, which is then bent as indicated and fastened in place with finishing nails. This method does away with loose wedges.—O. Lovejoy.

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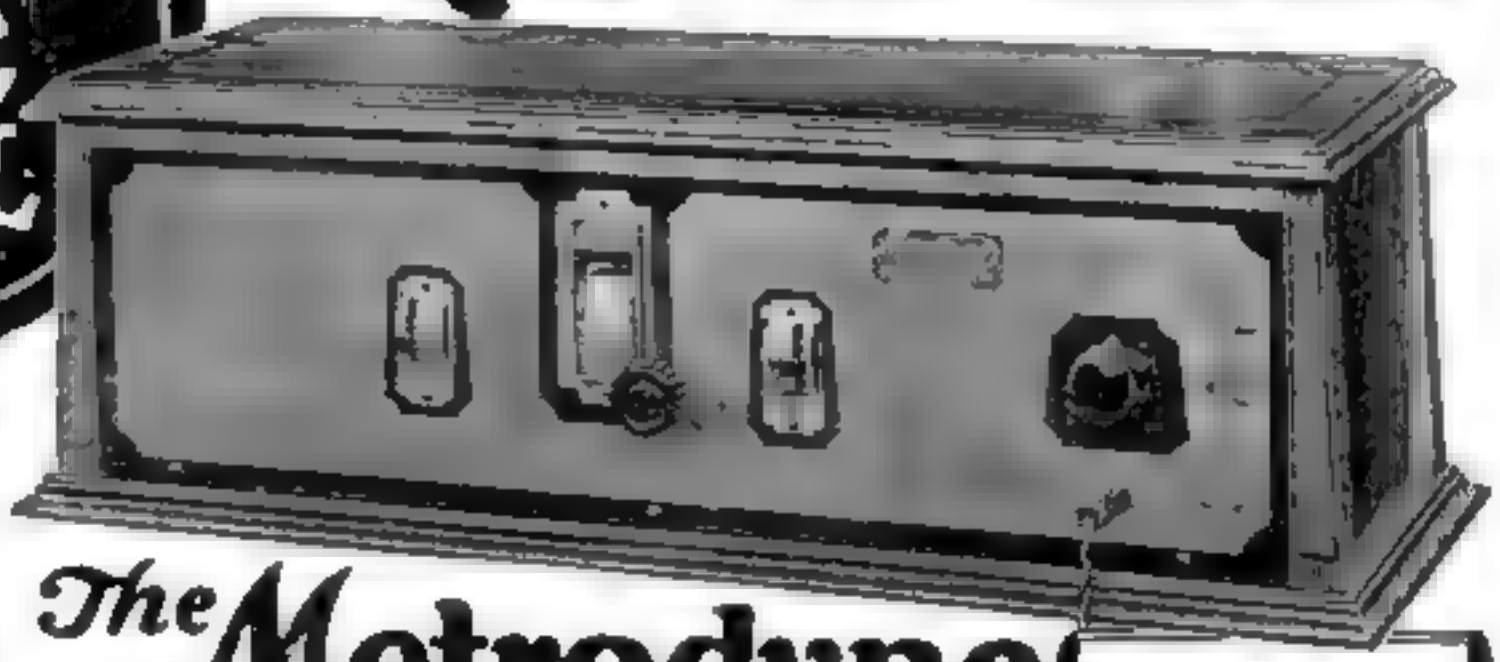

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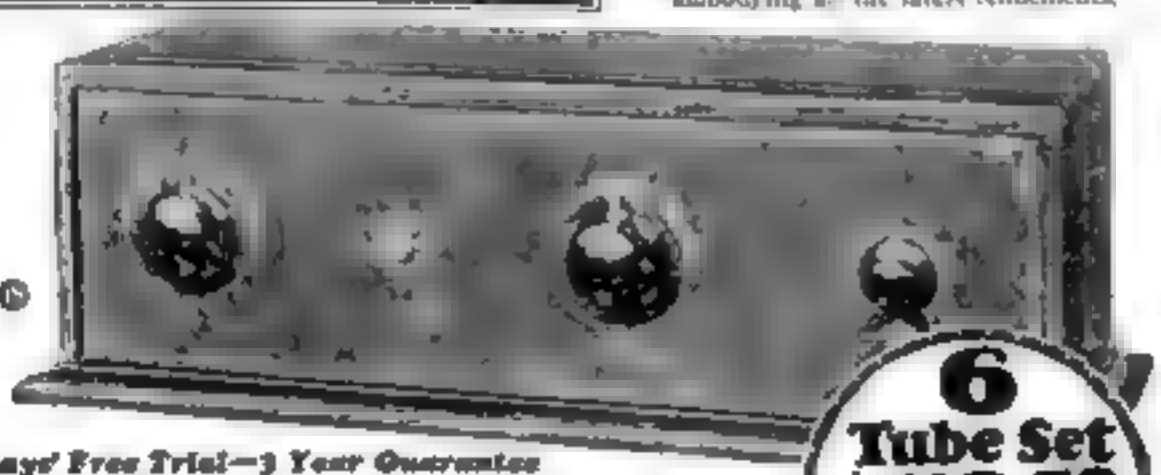
Easiest set to operate. Only one small knob tunes in all stations. The dial is electrically lighted so that you can log stations in the dark. The volume control regulates the reception from a faint whisper to thunderous volume, **1,000 to 3,000 miles on loud speaker!** The Metrodyne Super-Seven is a beautiful and efficient receiver, and we are so sure that you will be delighted with it, that we make this liberal **30 days' free trial offer.** You to be the judge.



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Mr. Howard, of Chicago, said, "While five Chicago broadcasting stations were on the air I tuned in seventeen out of ten stations including New York and San Francisco, on my loud speaker here, very loud and clear, as though they were all in Chicago."

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J. W. Woods, Leadville, Colo., writes: "Received the 7 tube Metrodyne in fine condition. Had it up and working same day received. Was soon listening to Los Angeles, San Diego, Oakland and other California points also St. Louis, Kansas City and Chicago and could hear every number in fine. Am more than pleased. Sure enjoying it."

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A Cube for You to Whittle

It's a Queer Puzzle Made of Interlocking Pieces

By Arthur L. Smith

CUBICAL block puzzles are made of blocks of various sizes and shapes. In this article one is offered that consists entirely of blocks ½ in. square and 2 in. long (Fig. 1). Many readers already may have whittled puzzles of this character in other ways, this article merely points out one way of doing it and is presented as a suggestion rather than the last word on the subject.

Twenty blocks (Fig. 2) are perhaps the fewest number which can be employed to bind all together compactly. The cuts are all ¼ in. deep, ½ or ⅝ in. wide, and ¾, 1⅛ or 1⅝ in. long. The distance of the cuts from the ends is either ⅜ or ⅝ in. Larger blocks may be used if the same proportions are observed.

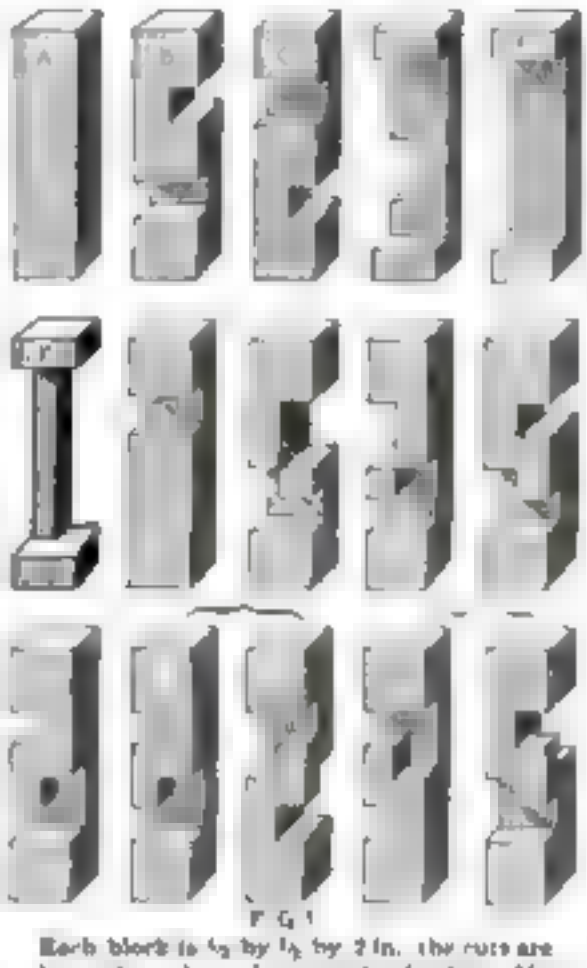


FIG. 1

Each block is ½ by ½ by 2 in. the cuts are ¼ in. deep, ½ or ⅝ in. wide, ¾, 1⅛ or 1⅝ in. long, and begin ⅜ or ⅝ in. from ends

The illustrations show the character of the cuts more clearly than can be described. Two views each of L and M are given in Fig. 1. The ¼-in. square cuts in H and I are larger than necessary and they may be cut on a bevel instead as indicated by the dotted line in the illustration of H. The square cut may add something to the difficulty of the solution since there are many ways in which other blocks may be fitted into it.

Perhaps neater work can be done if all blocks except F are cut slightly longer than 2 in. All measurements then are taken from the center. When the puzzle is assembled the cube can be finished up true with respect to the ends. The F block must be cut exactly to size, for if the square heads are thicker than ¼ in. the blocks cannot be assembled.

If numerical values are assigned to the blocks as described in a former article (May 1927, issue) it will be found that they total 134 or 6 more little cubes than the cubical contents of 4 solid blocks. Hence, there are internal spaces in the cube amounting to six ⅜-in. cubes. These are necessary to allow of assembling.

The first step in assembling is to arrange M K J and L with D and E protruding through the mortised holes as shown in Figs. 4 and 5. Then the other block E is laid in position (Fig. 6), and another tier of blocks K H C J is built on (Fig. 7). It will be necessary now to arrange the top tier L J K M on this combination Fig. 8) and raise them so that the block F can be fitted (Fig. 9).

Some manipulation is required to place the H and I blocks (Fig. 10). The H block is slid through the vacant tier so that the projecting head of F will pass through the ¼-in. slot. After it has been brought through as far as the D block will allow it can be brought around and slid forward so as to occupy the position shown in Fig. 11. The same process is followed with block I. No difficulty should be experienced with the remaining G and A blocks (Fig. 3). G is inserted through the A hole first and slid into place.

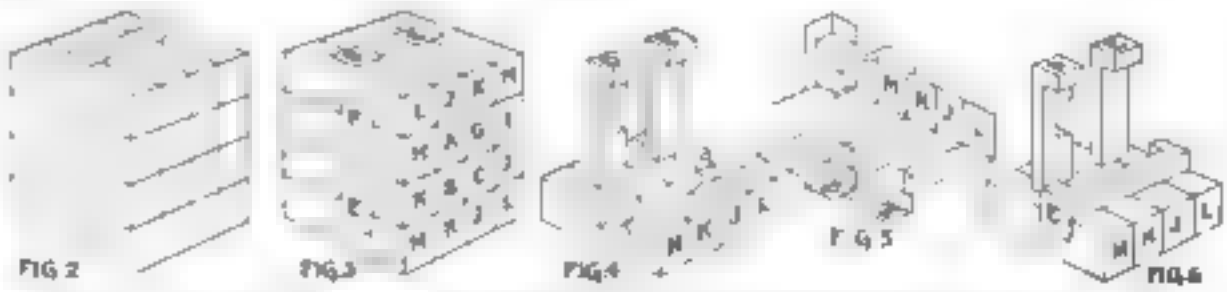
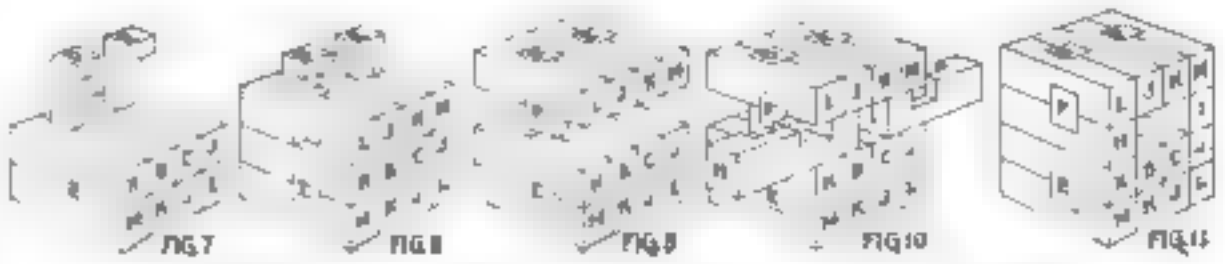
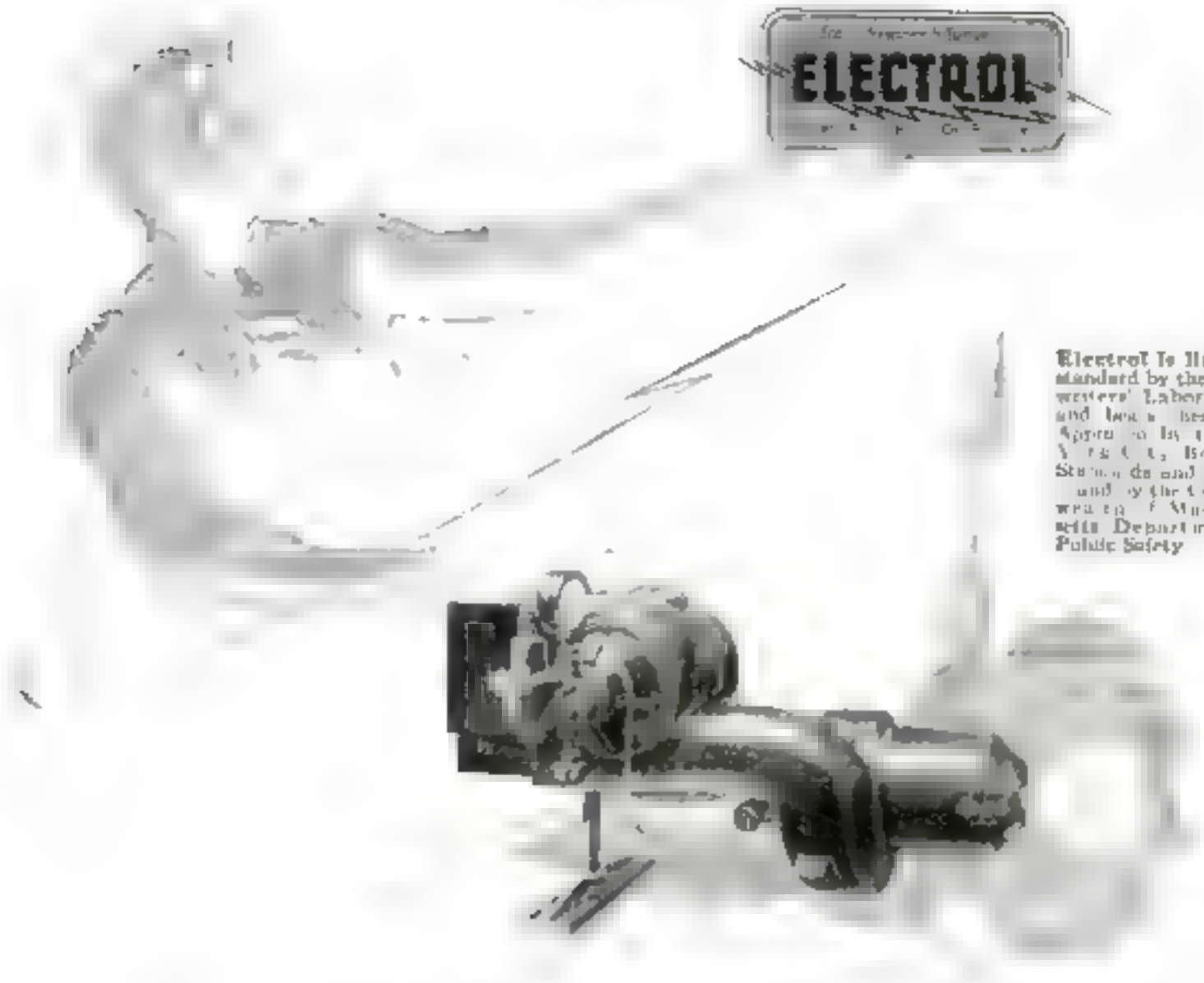


Figure 2 shows the assembled puzzle and Fig. 3 is lettered to identify the blocks, each of which is cut as shown in Fig. 1 above. Figures 4 and 5 show the first, Fig. 6 the second step



Another tier of blocks, K B C J, is built as in Fig. 7; then the top layer, L J K M, is added (Fig. 8) and F placed as in Fig. 9. H and I are added (Figs. 10 and 11) and finally G and A are inserted



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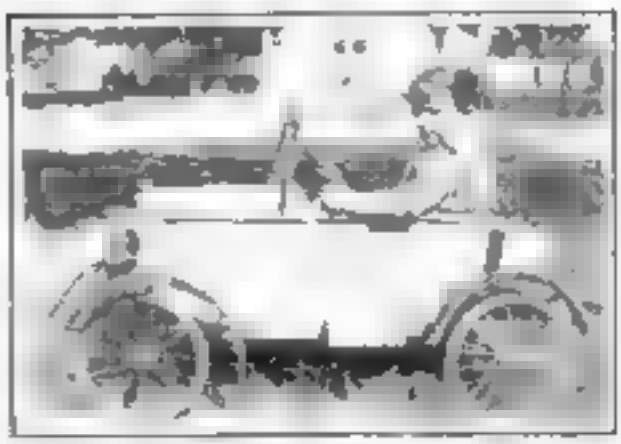
Toy Auto Built for Speed

By CARL G. ERICH

MY BOY drives the largest and fastest toy auto in our town yet its cost was *low* because I built it mainly from odds and ends. Any resourceful ingenious handy man can make one like it.



Painted orange, with black and white trimmings, this auto would delight any small boy

Strips of white pine 1¼ by 2 in. were screwed together to form the main frame. The radiator frame was cut from 1¼ in thick pine and heavy, square mesh wire cloth was fastened on the inside.

The back of the seat was built up with wood ribs; then tin was bent around the outside and upholstery fastened on the inside. The seat cushion was made by upholstering a ¾-in. board and laying it in place.

The doors were made of ¾-in. white pine, covered with tin outside and cardboard inside. Cupboard catches were attached before the doors were covered.

The steering wheel was cut from a 1-in black walnut board 9 in. square. To form the spider, a small gas pipe was split and spread out.

For the windshield, a wooden frame was made, the glass being held in with a beading of wood. An instrument board was provided for the light switch and a watch.

Two old bicycle rear-wheel guards were cut and bent to form the fenders. In the process they were flattened somewhat and given a more realistic appearance. Iron brackets underneath the frame support the steps.

The lamps are bicycle headlights wired to a switch on the dash. Two dry cells for the lights are clamped underneath the hood. The rubber-tired ball-bearing wheels are of a type that can be purchased from large mail order houses and some hardware toy and manual training supply houses.

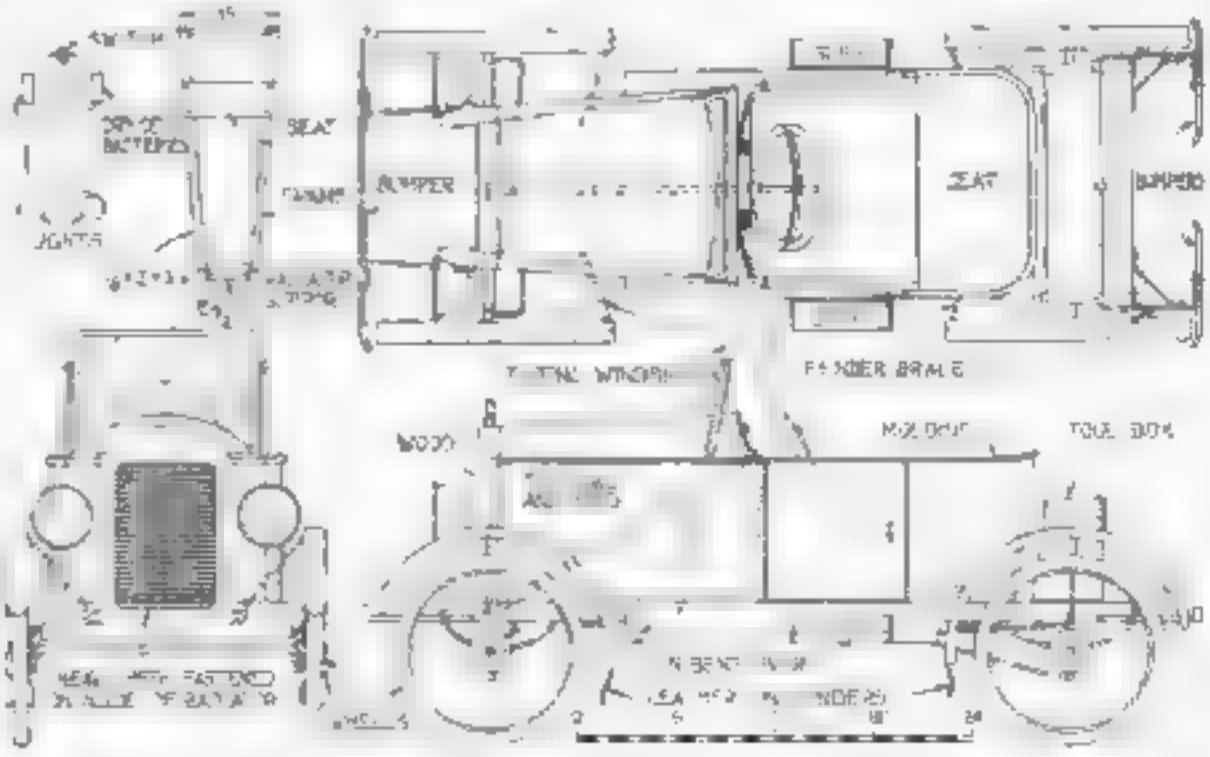
The crank hangers are about 7 in long. The cranks on the rear axle are bent so as to give about a 3-in stroke. The seats are 3-in blocks of hardwood with holes bored lengthwise in them. An inspection of any commercial toy with this type of drive will give a clear idea of the construction to those not already familiar with it.

The bumpers were made from the bows of an old baby buggy top. In place of a tool box, a turtleback, like that of a roadster, might be built, if preferred.

I painted the car orange on the body except the top of the hood, which is white. The radiator was given several coats of aluminum, the molding around the top edge and the windshield frame were painted black and the fenders, axles and wheels, orange. The instrument board and steering wheel were varnished.

Dusty Gray Finish for Oak

A GRAY antique-looking finish for oak can be had by covering the wood with two coats of a five-percent solution of silver nitrate, followed by a solution of hydrochloric acid. Set aside to dry in a dark place, then neutralize the acid with a coat of ammonia, which should be applied out of doors, as the fumes are very powerful. Do not touch the work with your fingers during the process, for the marks may show. Finish with well-rubbed coats of paste floor wax.—L. D. C.



Side, front and top views of the toy and diagrams of the main frame and wiring. The dimensions may be modified to suit the available materials and the age of the boy who is to drive the machine

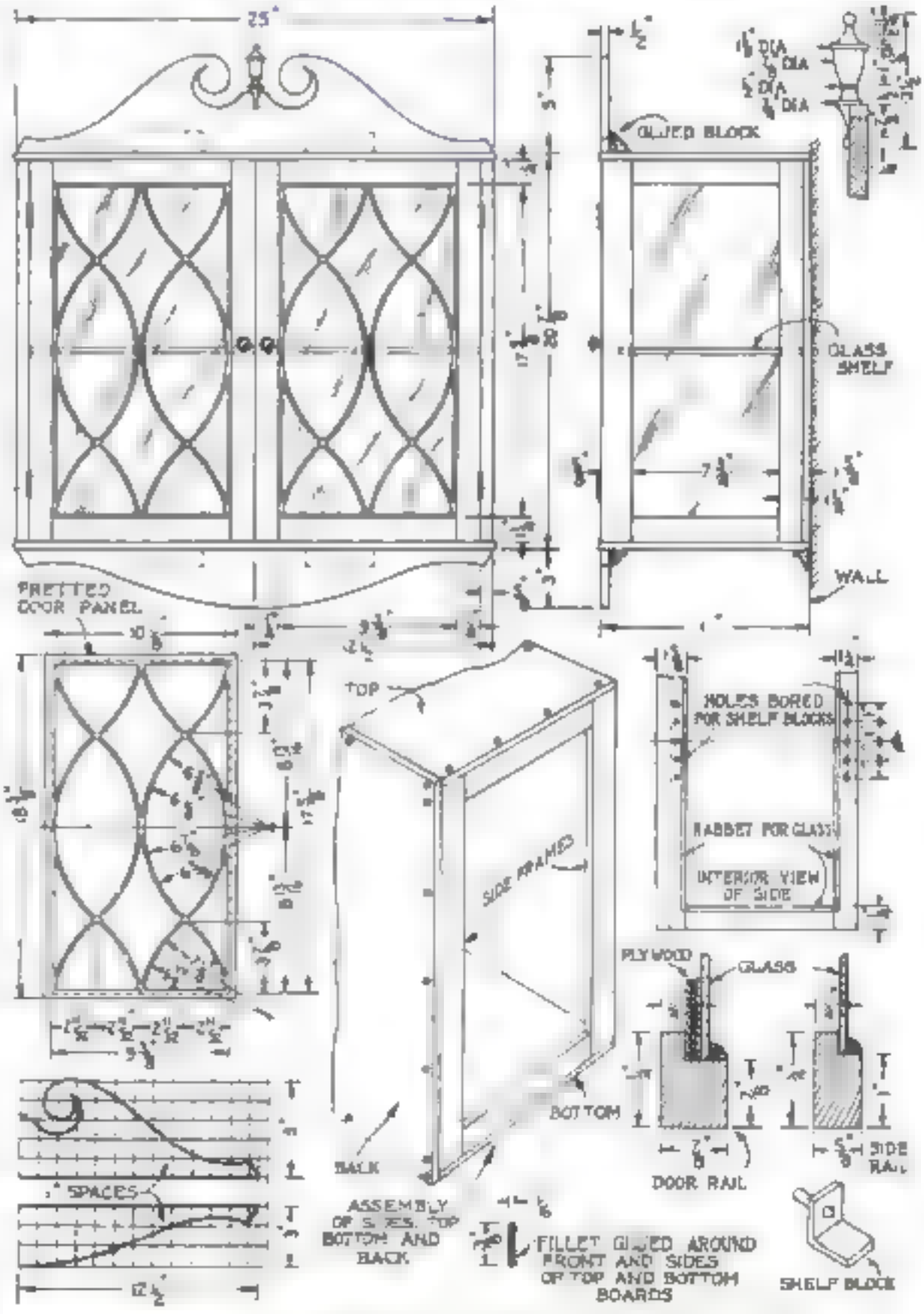
 See page 6.

A Cabinet for Your Curios

How to Build a Hanging Case of Unusual Beauty

THIS wall cabinet, which is intended to hang over a sideboard, between two windows, or on any suitable wall space may be used for china, curios, or scientific collections or instruments. If the sides and shelf were made of wood it might even be used as a hanging bookcase.

The pleasing proportions of the cabinet, which was designed by Art Director Ibsken of POPULAR SCIENCE MONTHLY, are not the result of chance. They were worked out scientifically upon the basis of the so-called Hambidge theory of dynamic symmetry. That is a remarkable system of Continued on page 144



Front and end views of the wall cabinet, the method of assembly, and details of the members of side frames, door rails and door frets, and the ornamental features at top and bottom

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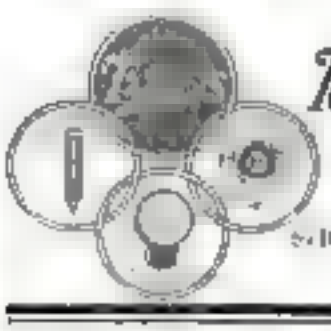

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INDICATING - RECORDING - CONTROLLING

Adding a Room to Your House

How to Utilize Space in the Basement if It Is Reasonably Large and Damp Proof

By Bruce Brighton

This remarkably attractive basement room was recently fitted up in the Detroit home of a friend of Mr. Brighton's. The color scheme is based upon yellow walls, sage green woodwork and tile red floor

"I HAVE a surprise for you!" exclaimed Mrs. Andrews before we had a chance to settle ourselves in the comfortable wicker rockers on the porch. "We have been doing some decorating. Come inside and let me show you."

Mrs. Andrews led the way through the hall and opened the basement door. The stairway had been newly painted—the walls a cheery sunny yellow and the woodwork and stairs a sage green. There were rubber treads down the middle of the steps to protect the finish.

We followed her down and at the bottom were astonished to find ourselves in a really wonderful room. And once it had been a commonplace and unattractive basement! It had been exactly the sort found in the average home—a housing place for the furnace, fruit cellar and laundry tubs. But this basement had come into its own.

The room, which was about 14 by 24 ft., had yellow walls, sage green woodwork, an attractive fireplace, window drapes in green and red figured cretonne with curtain poles painted red to match, two handmade benches with wrought iron ends and wooden seats and backs painted in sage green and red, one on each side of the fireplace, a radio cabinet in sage green trimmed with red and a bridge lamp to match. Upon the floor, which was painted in tile red, were several rugs.

After we had congratulated Mrs. Andrews, we asked how she had managed to convert the basement into so bright and comfortable a room.

"I'll tell you the whole thing," she began. "First we partitioned off the room from the remainder of the basement by erecting twenty-four studding, covered with wallboard on the inside, with a doorway out to the furnace and laundry tubs. The ceiling also was lined with wallboard. This proved more of a job than we anticipated, but there was nothing really difficult about it beyond the figuring we had to do to get everything square and straight.

"Next came the fireplace. We used to have many cobblestones in this neighborhood and it so happened that we had stored some in a corner of the basement. We had a mason come in and build the fireplace with these stones. The only other work we had done for us was the making of the benches.

"Then we started the painting and decorating. We gave the wallboard surfaces a coat of flat wall paint mixed with an equal part of wall size, using ivory white for the ceiling and cream for the side walls. A couple of days later, when this coat had dried thoroughly, we filled all holes and cracks with a prepared crack filler. We could, of course, have nailed strips of molding over the joints, but we did not want a paneled effect. Next we gave the wallboard two coats of flat wall paint just as it came in the can. We found that by using zigzag strokes the brush marks were less apt to show."

"What surprises me," I interrupted, "is that you were able to make such a good job of painting the concrete blocks of the foundation on the other three walls."

"It was hard to get the surface in shape," Mrs. Andrews admitted. "We used a stiff broom and where there seemed to be some salts or

(Continued on page 115)

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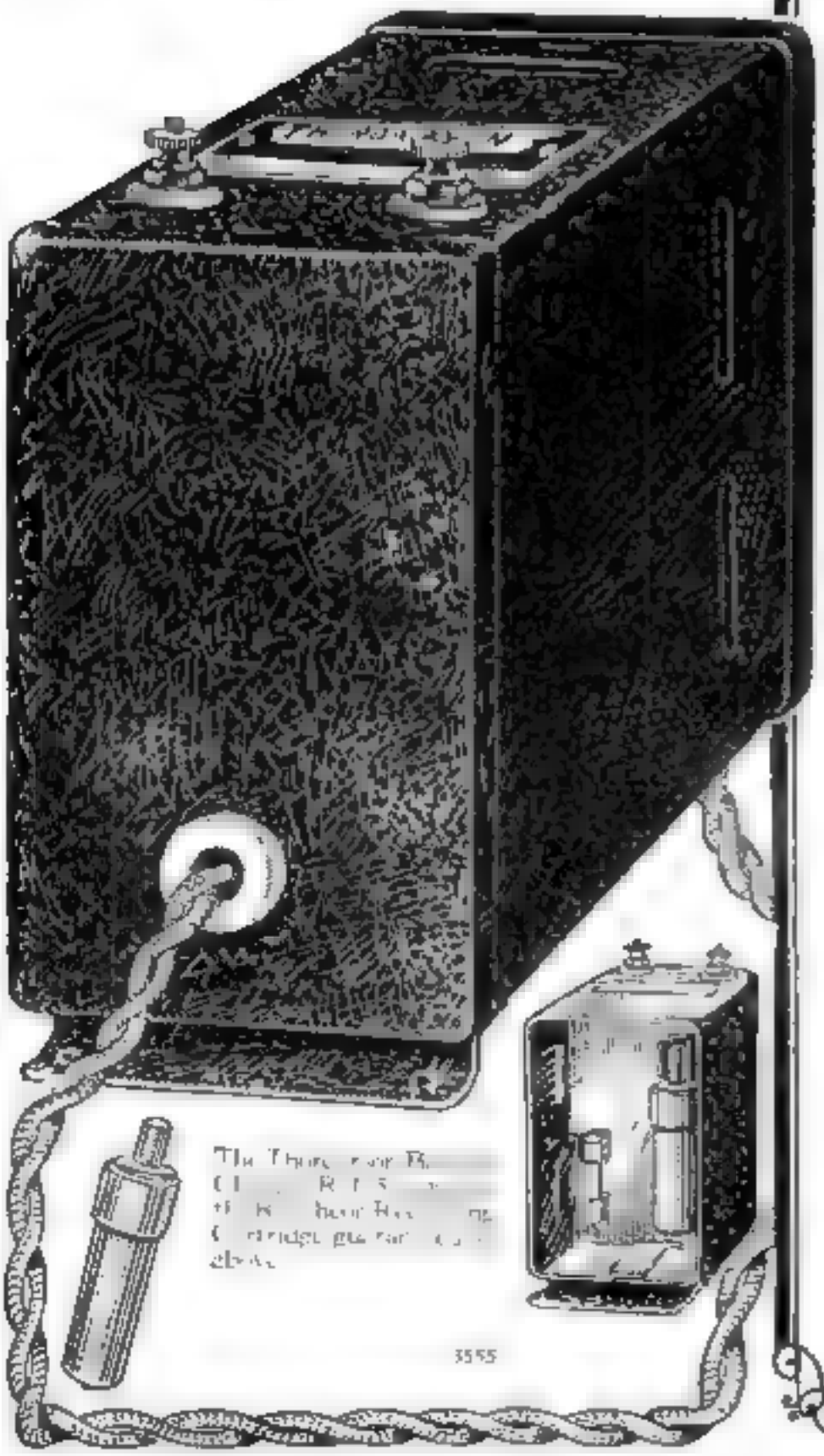

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An Aquarium *at* Low Cost

How to Assemble a Goldfish Tank of Wood and Window Glass

By HI SIBLEY

A neatly made, well kept aquarium adds a bit of life and color to any living room

GOLDFISH aquariums, like house plants, bring a colorful and refreshing bit of outdoor life into our homes. No wonder they are so popular!

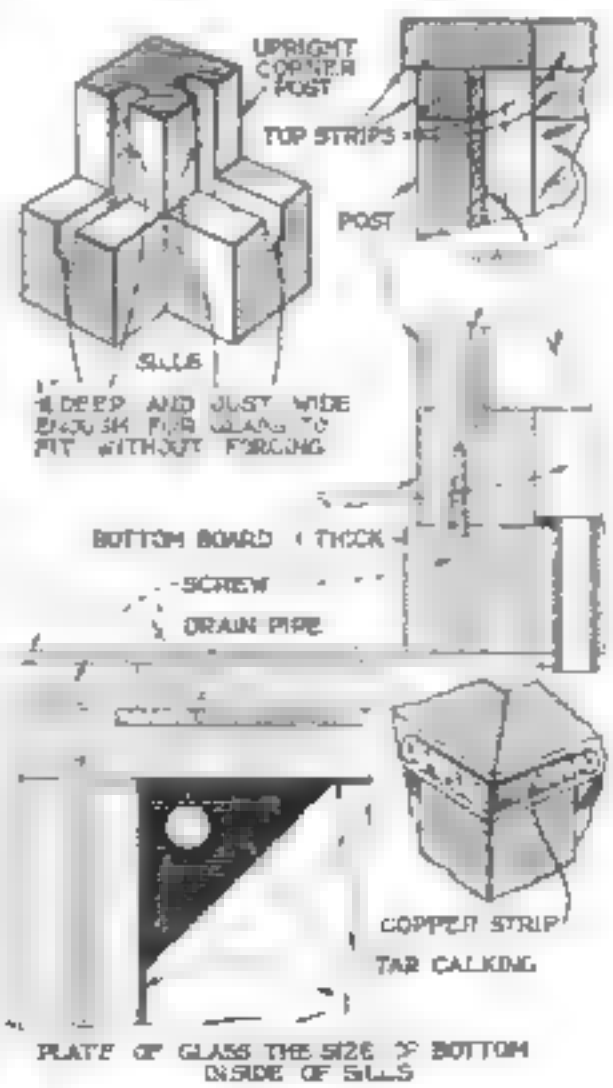
The advantage of the aquarium illustrated is that it can be made for about one third the cost of those of equal capacity on sale in pet stock stores. Besides, one has the joy of creative work in making it.

For the base board use a clear piece of dressed wood of tough texture that is not likely to split, and screw two substantial cross cleats underneath. A short length of ¾-in. brass tubing is driven into a hole bored in one corner of the bottom and a plug made to fit.

For the uprights and sills, use clear, hardwood pieces ¾ in. square. In my own aquarium the base is 1 by 12¾ by 20 in., the four uprights are 13 in. long, two of the sills are 10 in., and two 18 in.

If possible have the lumber company or sawmill cut grooves in two sides of the four uprights, and on one side of the sills. These grooves should be just large enough to receive the thickness of glass you intend to use, either double-strength window glass or plate glass.

The glass should be cut to leave about ⅛ in. clearance between the bottoms of the grooves in the upright wooden members.



Vertical section through one end of the aquarium and details of corner construction

The top strips, which are ¾ by 1¾ and ¾ by ¾ in., are put on after all the glass has been set. After painting and varnishing, use copper strips to tie the corners together.

It is advisable to varnish the inside of the grooves and set the glass before the varnish dries. An agreeable color for painting the frame is lettuce green. Two coats should be given. Paint close to the glass so that the paint will work into all crevices. Any paint which gets on the glass can be scraped off with a safety razor blade. When thoroughly dry, give all painted portions three coats of spar varnish, allowing plenty of time between for drying.

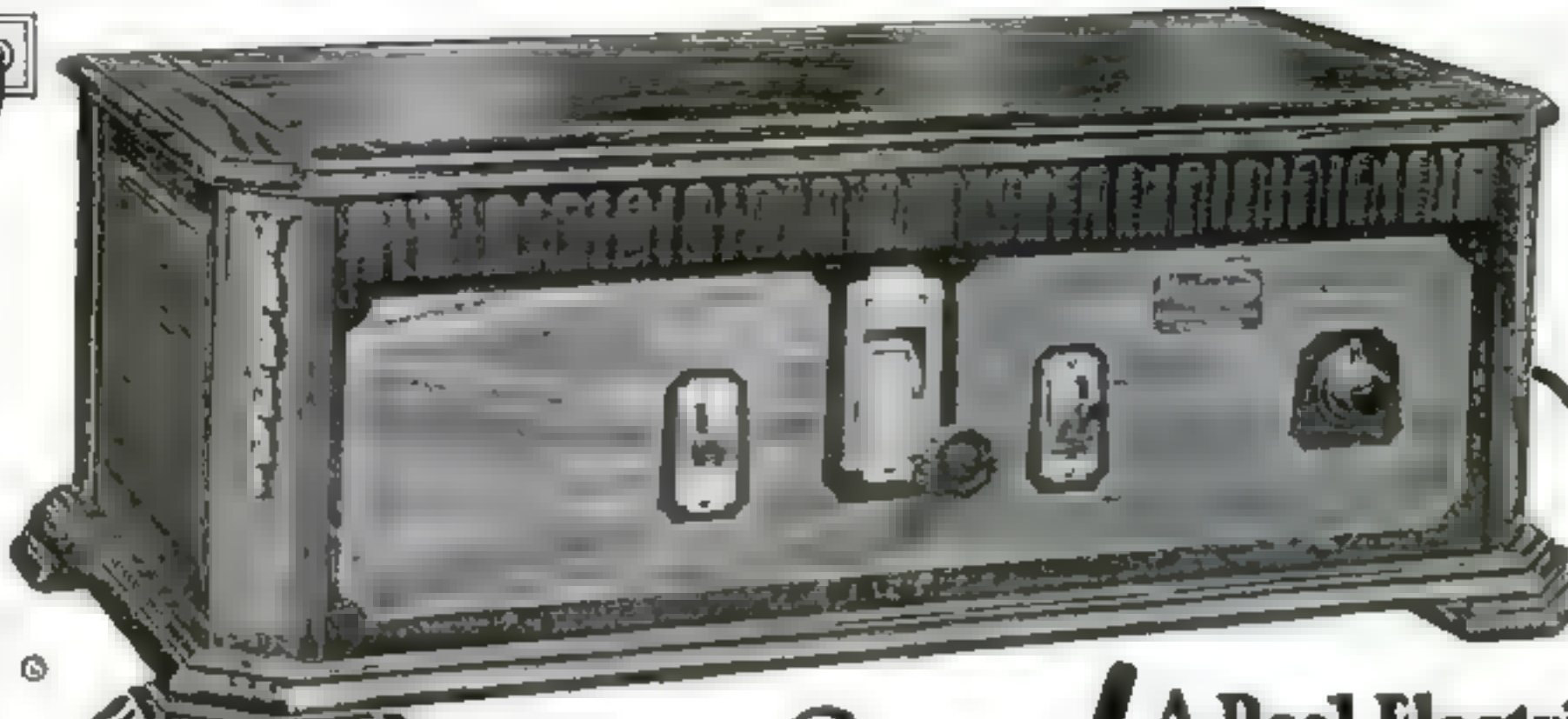
Now lay a pane of glass on the bottom, having first cut one corner away where the drain plug is placed. Around the edges and at the exposed corner, cover the wood with tar, heated until it is about the consistency of putty. It is not necessary to paint this tar; the sand in the bottom of the aquarium will cover it up.

AFTER everything is thoroughly dry, fill the tank with water two or three times and drain off; fill again and let stand twenty-four hours and drain. Now the aquarium is ready for sand, rocks and plants, *but not for fish;* at least that has been my own experience. Wait a week or so after the plants are installed.

For variety, you can include a small turtle, if you don't mind the plants being sheared off and the fishes' tails scalloped. A small schooner, the hull of which was whittled from a piece of wood 1 by 1½ by 4¾ in., is anchored in the center of my aquarium for the turtle to bask on and from which to "speak" for his meals. Turtles are readily tamed by feeding with small bits of raw beef on a broomstraw.

Select your fish with a view to variety and you will have agreeable entertainment. Name them to suit their appearance and temperament, which you will find varies as much as in domesticated mammals.

The water need be changed only once a week, or at longer intervals.



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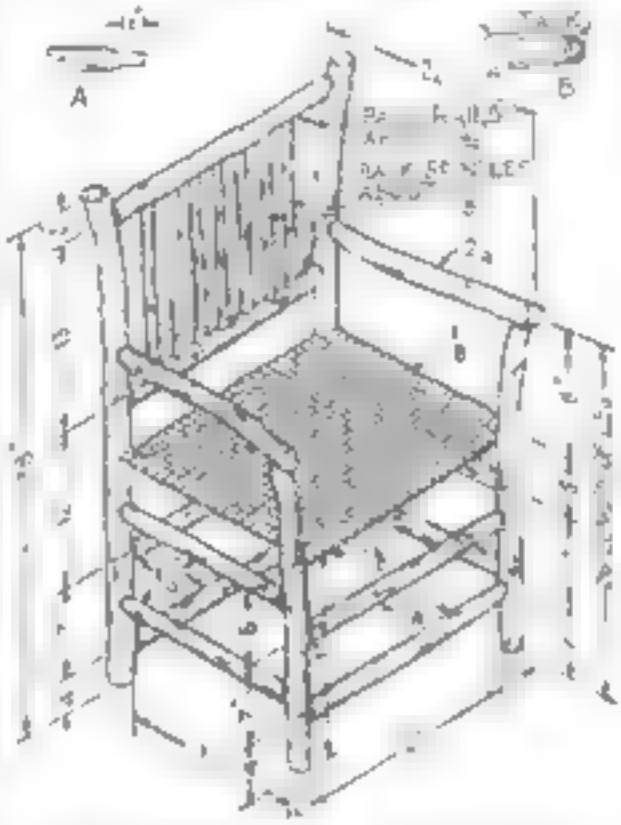
Campcraft for Everyone

Making Chairs and Tables—Fishing Tackle Box—Quaint Knocker—Pine-Cone Parrot—Sawbuck

CAMPERS who are able to cut their own oak, hickory or other hardwood poles will find the making of a rustic chair like that illustrated below an interesting project.

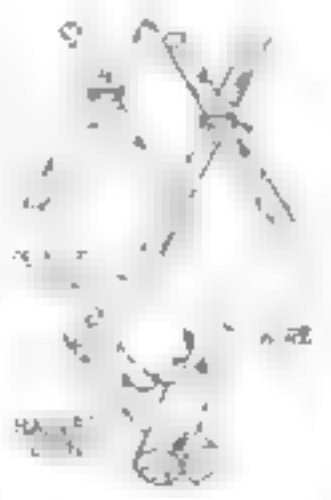
If the splints for the seat cannot be purchased locally, wide cane or flat rattan may be used instead, or the seat may be woven with rush, fiber, leather thongs, heavy, narrow webbing, or any other suitable material.



Substantial and decorative camp chair made of hardwood poles with a woven splint seat

It is always an advantage, of course, in making furniture of this type, to cut the poles in the late fall so that the bark will not peel. If poles with the necessary curves cannot be found, the wood may be bent while green and put away to season.

Assemble the parts with frames made as shown at A, and glue well. If splints are used for the seat, wet them thoroughly and begin at a corner, as shown at B.



WHEN much firewood has to be sawed up in camp, a sawbuck is essential. One may be made quickly by pointing and notching four short, heavy poles as shown, and driving them firmly into the ground. The joint should be bound with wire or rope.

AN AMUSING novelty for a camper to make in his spare time is the rustic knocker illustrated. The back is a slab sawed diagonally from a white birch or other log. One side is planed, if a plane is available, or else scraped smooth with a jackknife or a bit of glass. The lettering is carved in with the point of a knife, burned in, or painted on as preferred. A suitable branch is chosen for the striker and mounted as shown so that it will swing.

Rustic knocker

MANY attractive novelties may be made from materials the camper can find all about him. A small sized pine cone, for example, will form the body for a colorful and decorative little parrot.

To the stem end glue an acorn cup or something similar, as shown. Cut the beak from wood, cardboard, or gasket paper, and glue it in place.

This tiny parrot with its gay feathers is an amusing and colorful novelty for camp or home

The wire rug represents both perch and feet. Bent as shown, the loose ends are fastened to the cone with a drop of sealing wax or other adhesive. A few colored feathers complete the model. Beak, eye and rug are painted, but not the cone.

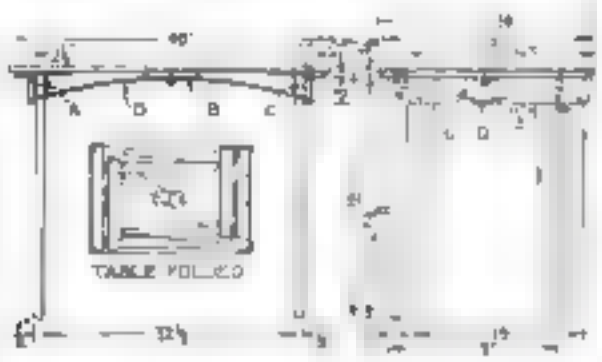
At home, the parrot may be hung by means of a silk cord from a window shade, lighting fixture, or other support.
—F. Charles Higgins.

HOW often have you wished you had extra tables and chairs for the use of unexpected camp guests? It is easy enough, of course, to purchase various types of folding tables and chairs, if there is a camping equipment store near by, but it is much more fun to make them.

The folding table illustrated on the opposite page has a top of ¾-in. matched boards, preferably glued together. The wood should be reasonably hard so as to hold the screws. (Continued on page 99)

Campcraft for Everyone

(Continued from page 98)

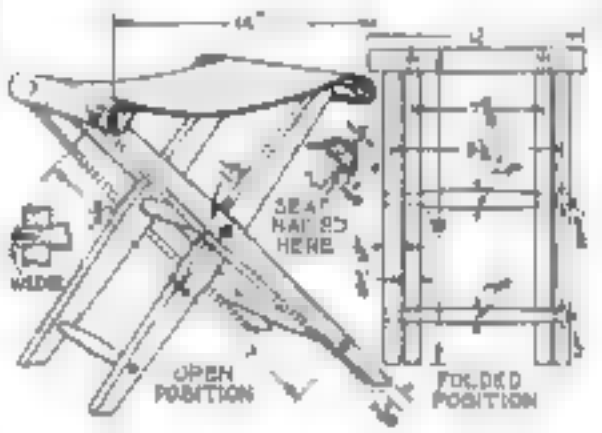


Ends and side views of a light table and underneath view of top when legs are folded

Cleats ⅞ by 2½ by 23½ in. are fastened under the top with 1-in. No. 9 screws.

Make four legs as shown and two rails ⅞ by 3 by 21 in. and assemble with 1½-in. No. 10 screws and glue. Fasten legs to tube with 3-in. strap hinges, using ½-in. No. 8 screws. Fasten three blocks A, B and C, ⅜ by 3 by 6 in., with glue and 1-in. No. 9 screws. Make spring D of hard wood, ⅛ by 3 by 30 in., and fasten it in the center with one 1½-in. No. 14 round-headed screw and washer.

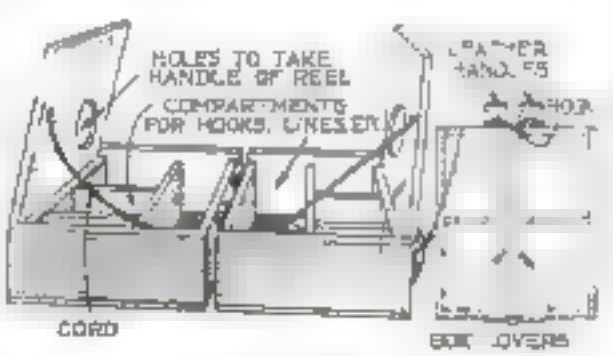
When making folding camp stools, you will find that ash, oak, maple or red birch



A sturdy folding camp stool for the outdoor man who never buys anything he can make

are better than the softer woods. A good method of fastening the pins or tenons is to elongate each hole a trifle with a round file, make a cut with a thin saw in each pin and, when the joint is together drive a wedge to expand the pin. Use glue except in the joints which have to turn. Fasten on a seat of stout canvas, saw off the legs at the correct angle, and finish with paint or varnish.

TWO cigar boxes may be hinged together and fitted up as shown below to make a small but convenient tackle box for the fisherman who has to improvise his equipment on short notice. Scrape and sandpaper the exterior and apply dark green or black brushing lacquer.



How two cigar boxes may be hinged together and partitioned to hold fishing tackle

My Motorized Shop Cost $20

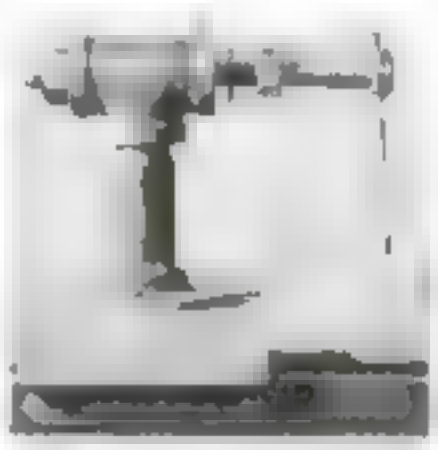
follows: A nut is run on the bolt so that it will be inside the T, and the two lock nuts and washers are tightened so that the bolt will be held in the correct position. Melted lead, babbitt, or type metal is then poured through the nipple into the T, so that the bolt is completely imbedded. Powdered graphite, chalk or similar material rubbed into the bolt threads

An old plane bit, because of its slot is an excellent base for the lathe tool rest

The assembled lathe. The live center is a heavy wood screw held in the drill chuck

beforehand will allow the bolt to turn easier after the metal has cooled. The assembly is mounted on a hardwood block. It is held to the angle iron bed by a small iron plate and two bolts, which may be loosened for adjusting.

The construction of the tool rest is shown clearly in one of the photographs. An old plane bit, a section of pipe with floor plate to fit, a large bolt and nut



A painted bolt forms the tail spindle of the lathe

a portion of an automobile inner tube valve, an iron rod, and a piece of strap steel are needed. A heavy wood screw, with head removed, is inserted in the drill chuck, and the work to be turned is screwed on. This holds even large pieces.

A sanding disk may be made from hardwood, drilled so that it can be screwed on the polishing end of the spindle, and covered with sandpaper or emery cloth. A simpler method is to cut a disk of sandpaper the size of the grinding wheel and clamp the paper and wheel together by means of the lock nuts.

Simple Straw Instrument Measures Humidity

By H. D. Tiemann

STRAW will make a simple but remarkably sensitive and accurate humidity indicator or hygrometer.

Split lengthwise into about six portions a 4 or 5 in. length of smooth clean straw, preferably wheat although any grain will do. This can be done most readily by crushing the straw flat on a table. If the straw is dry the inner portions are in a state of tension with respect to the outer surface so that the split pieces will tend to curl with the concave side toward the inner or pithy portion of the straw.

Near one end of a smooth board about 4 by 6 in. screw a section of a spool and insert one end of the straw in a narrow slot on the spool, as shown.

Wet the straw in warm water and it will at once straighten out. Place it for not more than two or three minutes in an oven heated to not more than 212 degrees F. and it will curl. Mark the two extreme positions of the end of the indicator 100 and 0 and divide the space between proportionately. This will give a scale for measuring relative humidities.

The straw straightens when the air is moist

Breathing on this instrument will demonstrate how exceedingly sensitive it is. Although it is not, of course, quite as accurate as a wet-and-dry bulb hygrometer, one can detect weather changes just as readily as with an expensive piece of apparatus.

It will be a surprise to many to find how dry their living rooms are during the winter time and how damp the rooms are on a hot summer day, when the interior of the house is cool.

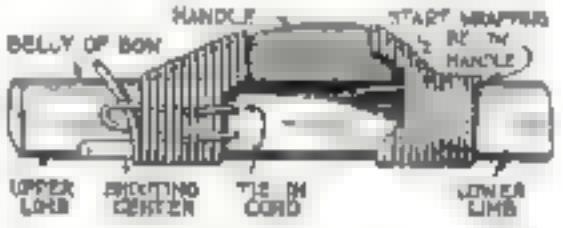
New Handle Aids in Shooting a Bow

By Willard D. Morgan

Jack A. Hoefer, a California archer, demonstrates a new bow grip that fits the hand

THE revival of the sport of archery has resulted in the designing of an entirely new type of bow handle by Jack Hoefer of Glendale California, who says that it distributes the pulling weight more evenly across the palm of the hand than does the English handle. It has been tested out thoroughly at a large university for the past four years and the shooting has been improved greatly.

This handle may be added easily to any bow. On a soft pine block 1¾ in.

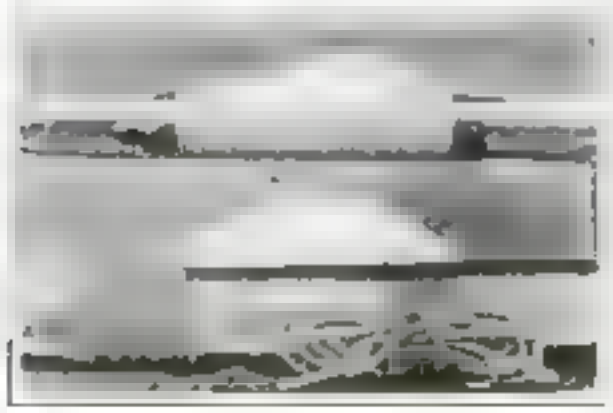


How the wooden handle block is shaped, fitted to the bow, and wrapped with cord

square and 8 in. long, draw a curve like that shown and cut and rasp the bulge to fit the palm of your left hand. Make allowance for the cord wrapping, the tendency is to make the block too thick.

Cut a groove in the underside to fit flush on the "belly" of the bow and glue the block in place with the tapered end just below the shooting center. Hammer in two short brads to hold the handle in position and apply liquid glue liberally on handle and bow.

Start the wrapping ¼ in. below the lower end of the handle and continue until you have reached the shooting center. Make an invisible ending with the aid of a tie-in cord. Drive short brads through the ends of the wrapping cord at the start and finish. Use a hammer handle to beat down the cord until it is smooth and even and for the final finish apply two coats of varnish or shellac.



A finished grip showing also the arrow plate, and a handle in the process of being wrapped

Mystic Lamp Sheds Its Light through a Crystal Ball

BY PAUL H. KEATING

A plaster of Paris inverse burner and a glass ball were used in making this lamp

WHEN a light is turned on inside the idol illustrated the ball becomes brightly illuminated and throws a shaft of light upward. The effect is very odd and charming. It is ideal for a smoking room or den and will lend a certain oriental atmosphere to any room.

A good plaster of Paris idol holding a bowl of incense was obtained. Three holes were cut into the rear, which was hollow, one about ½ in. in diameter through the bowl, one in the back to hold the electric fixture and a larger hole in the bottom to give working room for assembling the electric light and socket.

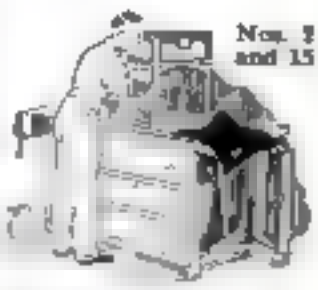
Section through idol showing light socket

A small amount of plaster of Paris was spread around the bowl and a ball of cotton "crystal ball" set into it. When the plaster had hardened, the rough edges were trimmed and painted with gilt to match the rest of the idol.

A 10-watt lamp is about as large as can be inserted in an idol of this size. The total cost was less than eleven dollars.

WHEN worn hollow an oilstone may be resurfaced by rubbing it over any flat metal surface, upon which coarse emery or other abrasive has been sprinkled.

Blueprints for Your Home Workshop



Nos. 2 and 15

ANY ONE of the blueprints listed below can be obtained for 25 cents. The blueprints are complete in themselves, but if you wish the corresponding back issue of the magazine, in which the project was described in detail, it can be had for 25 cents additional so long as copies are available. The editor will be glad to answer any specific questions relative to tools, material, or equipment.

POPULAR SCIENCE MONTHLY
250 Fourth Avenue, New York

GENTLEMEN:

Send me the blueprint, or blueprints, I have underlined below, for which I inclose ____ dollars ____ cents:

No.	Title	Described in Issues of		Price
1.	Sewing Table	Feb.,	'22	25c
2.	Smoking Cabinet	Mar.,	'22	25c
3.	End Table	Apr.,	'22	25c
5.	Kitchen Cabinet	May,	'22	25c
8.	Shaving Cabinet	June,	'22	25c
9.	Arbor Gate and Seats	July,	'22	25c
10.	Porch Swing	Aug.,	'22	25c
11.	Bench and Tile Table	Sept.,	'22	25c
12.	Electric Washer	Oct.,	'22	25c
13.	Tea Wagon	Nov.,	'22	25c
14.	Christmas Toys	Dec.,	'22	25c
15.	Workshop Bench	Jan.,	'23	25c
16.	Inlaid Radio Cabinet	Feb.,	'23	25c
17.	Cedar Chest	Mar.,	'23	25c
18.	Phone Table and Stool	Mar.,	'23	25c
19.	Grandfather's Clock	Apr.,	'23	25c
20.	Flat Top Desk	Apr.,	'23	25c
21.	Colonial Desk	Apr.,	'23	25c
22.	Cabinet and Desk	Apr.,	'23	25c
23.	Pergola Garage	May,	'23	25c
24.	Gateleg Table	June,	'23	25c
25.	Canoe Sailing Outfit	July	'23	25c
26.	Baby's Crib and Pen	Sept.,	'23	25c
27.	Kitchen Cabinet Table	Oct.,	'23	25c
28.	Pullman Play Table	Nov.,	'23	25c
29.	Toy Tea Cart etc.	Dec.,	'23	25c
30.	Tool Cabinet etc.	Jan.	'24	25c
31	Sewing Cabinets	Feb.,	'24	25c
32.	Chinese Game Table	Mar.,	'24	25c
33.	Dining Alcove	Apr.,	'24	25c
34.	Garden Trellises	May	'24	25c
35.	Simple Radio Cabinet	Oct	'24	25c
36.	Rush-Bottom Chair	Nov.,	'24	25c
37	Simplified Bookcase	Dec.,	'24	25c
38.	Sheraton Table	Jan.,	'25	25c
39.	Salem Chest	Feb.	'25	25c
40.	Desk in Sheraton Style	Mar	'25	25c
41	One Tube Radio Set	May,	25	25c
42.	Three-Stage Amplifier	June,	'25	25c
43	Four Tube Receiver	July	'25	25c
44.	Pirate Ship Model—Hull	Feb.,	'26	25c
45.	Pirate Ship—Details	Mar.,	'26	25c
46.	Galleon Model—Hull	May	'26	25c
47.	Galleon Model—Details	June	'26	25c
48.	Sailing Yacht Model	July,	'26	25c
49.	Broom Cabinet	Aug.,	'26	25c
50.	Airplane Model (Flying)	Sept.,	'26	25c
51	Copper Ship Model—Hull	Oct.,	'26	25c
52.	Copper Model—Details	Oct.,	'26	25c
53.	Copper Model—Rigging	Nov.,	'26	25c
54.	Five Tube Radio Set	Oct.,	'26	25c
55.	Five Tube Set—Details	Oct.,	'26	25c
56.	Bird and Animal Toys	Dec	'26	25c
57	Constitution Model—Hull	Jan.,	'27	25c
58.	Constitution—Rigging	Feb.,	'27	25c
59.	Constitution—Rigging	Mar	'27	25c
60.	Welsh Dresser	Mar.,	'27	25c
61	Viking Ship Model—Hull	Apr.,	27	25c
62	Viking Ship—Details	Apr	27	25c
63.	Toy Motor Boat—Hull	May,	'27	25c
64.	Toy Motor Boat—Details	May	'27	25c
65.	Six Simple Block Puzzles	June	'27	25c
66.	Ship-Model Weather Vane	Aug.	'27	25c
67.	Toy Model of Lindbergh's New York-to-Paris Plane	Aug.,	'27	25c
68.	Magazine-Rack Table and Book-Trough Table	Sept.,	'27	25c

Name
(Please print name and address very clearly)

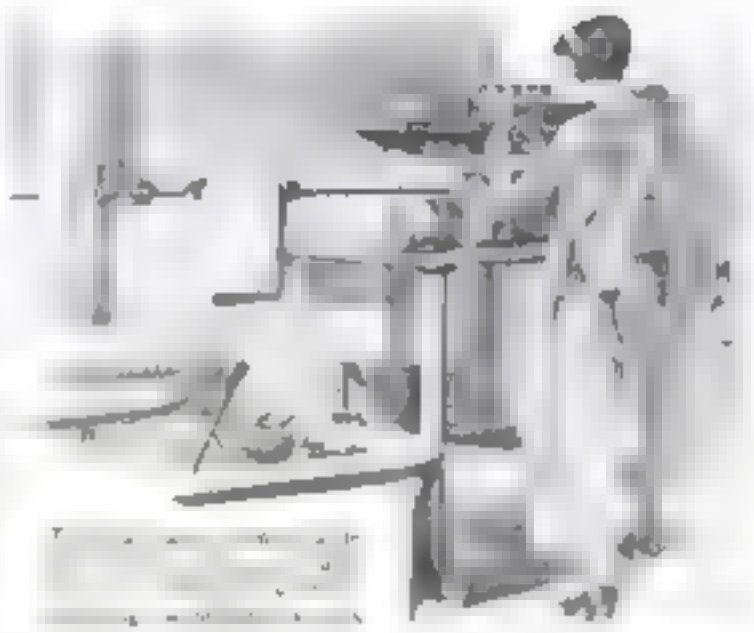
Street

City and State

A Dressing Table for Baby

It Fits into Small Bathroom—Quickly Removed After Use

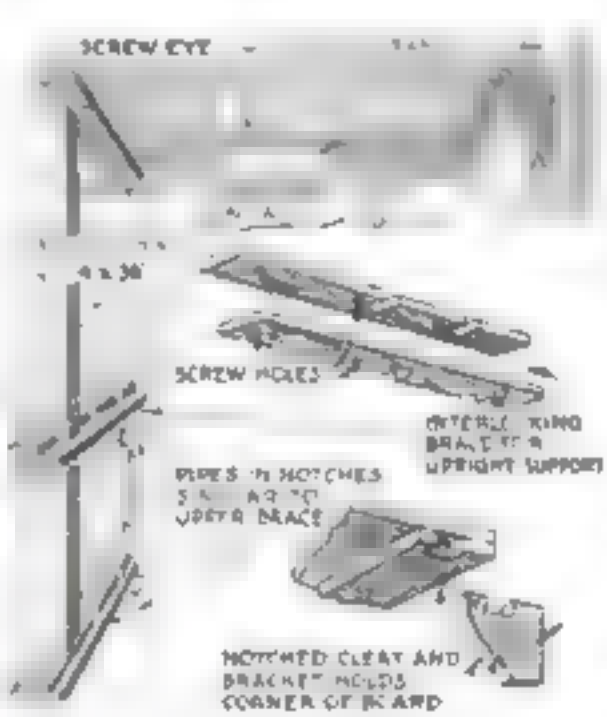
By CONSTANCE J. WARDELL



IN THESE days of modern efficiency and short cuts, we have dish washing machines and vacuum cleaners, but mother's knee is still very often the chief dressing station for wee babies. That's all wrong because it is a nervous strain on mother and an uncomfortable position at best for baby.

The solution is to erect an easily removable dressing table in the bathroom in such a way as not to mar the woodwork or fixtures. All this we accomplished with only a saw, hammer, chisel, screw driver, a few ¾ in. thick boards, and some nails and screws. Any one who is handy with tools can acquire an equally satisfactory baby board by applying the ideas outlined in the accompanying sketches to the particular arrangement of his own bathroom.

In our own case, the board itself is ¾ by 27 by 35 in., with cleats across the ends. It was necessary to notch out the right-hand front corner to suit the woodwork around the doorway, but this notch, being tight fitting, helps to steady the board considerably. It is supported at this corner by means of a bracket screwed to the door trim as shown.



How the table is constructed. Note particularly the way braces are attached to pipes

The left-hand front corner rests upon an upright support, which passes through slots in two wooden braces attached to the bathtub by the simple method illustrated. Each of these braces consists of two pieces suitably notched and shaped to fit the bathtub and the pipes and then fastened together with nails. Note that the upper end of the upright enters a mortise or slot cut right through the left-hand cleat under the table top.

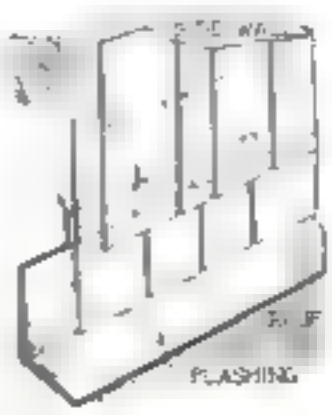
An ordinary leather or fabric strap may be nailed across the width of the top with both ends free for buckling around the baby's waist, and two screw eyes are inserted, one on each side of the board, to which the baby's safety strap may be snapped. These are for use when the baby has to be left for a moment or two for instance, when answering telephone calls.

The rear of the board merely rests upon the water tank. It can, therefore, be lifted up bodily and put away when not in use. The upright also may be withdrawn from its sockets, so that nothing is left in place except the bracket attached to the door trim and the tub braces.

If no other provision has been made for toilet articles, a shelf may be attached to the wall, just out of baby's reach.

How to Insert Flashing under Old Shingles

WHILE a new rear porch was being added to a dwelling recently, the question arose as to how to place flashing at the junction of roof and wall without removing and replacing a number of the wall shingles. Pieces of thin wood, cut from cigar boxes, were driven up under the shingles with a piece of thin hardwood until they were 1½ in. above the butts of the next higher course, as illustrated. A mark on the hardwood strip made it easy to place the pieces accurately.



Spacing strips allow the flashing to slide in

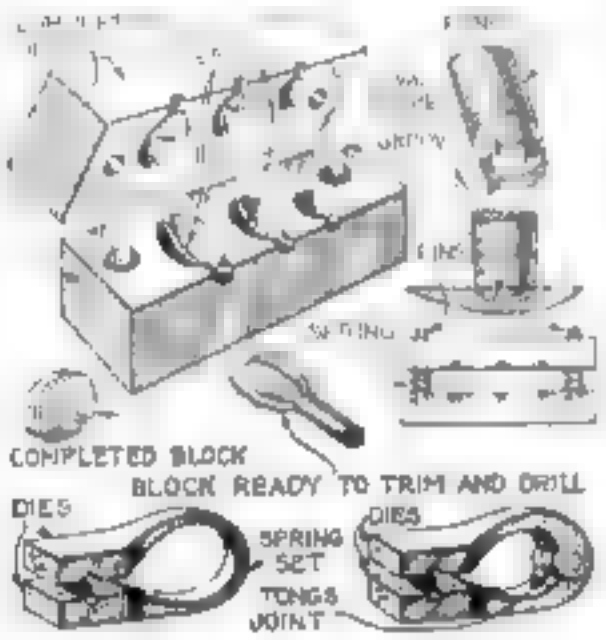
The flashing was then bent lengthwise on a straightedge so that the bend would come even with the roof. The flashing slipped into place easily; a few nails held it until the roof could be finished. This was done, of course, before the porch rafters were put in place.—ALVIN M. GULLY

Making Blocks for Ship Models

By F. L. Coes

BEFORE I was bitten by the model-making bug, I often saw fellow commuters unostentatiously whittling little slips of boxwood (old 2-ft. rules, as I afterward found out) into what seemed to be tiny wooden seeds. Inquiry elicited the information that these mysterious seeds were blocks for ship models.

My first need for anything of this kind was for two pairs of blocks for a watch tackle to swing the captain's gig on davits over the stern of a model motor boat. These I made from aluminum wire, in the same sequence as did the commuters, with the advantage that the metal, while harder to work, has no grain and may be drilled easily without danger of splitting. When I came to build a model that required many blocks of three sizes, this



How dies may be made for stamping ship-model blocks quickly from aluminum wire

method seemed far too slow and I devised an infinitely faster one.

On one end of three rods of high grade tool steel of suitable sizes, I formed a half block. These punches then were hardened and drawn to a brown-blue.

Next I obtained two blocks of steel 1 by 1 by 3 in., produced a flat surface on one side of each, clamped these surfaces together and drilled for guide rods. Then I annealed the blocks, laid out three parallel lines on each, working from a center line, and placing the blocks on an anvil, set the three impressions into each with heavy hammer blows. After a little shaping up with a file, the two dies were hardened and tempered to a deep straw.

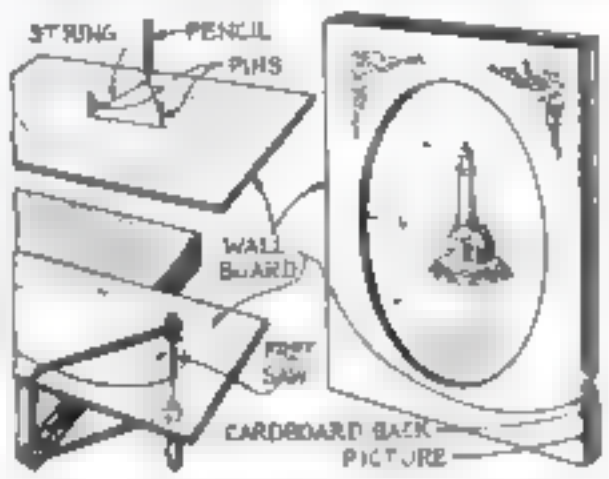
In use, this forming tool is clamped in a solid vise or used on an anvil. Two springs may be inset, as shown, to open the tool after each blow. A rod of aluminum wire, hard solder, annealed yellow brass or other soft alloy is put into the impression and a blow struck on the upper block. If necessary, turn the rod over, set it in the impression and hit it a second time. Don't close the dies fully with the rod in the impression, but keep the block on the rod so that it can be finished with a fine file before being (Continued on page 176)

How to "Frame" Pictures with Wallboard

FRAMES for the pictures you may cut from magazines can be made from scraps of fiber wallboard, as shown below. They may be painted, gilded or varnished. In some cases I have even grained the frames with good results.

As the saw leaves rather rough edges, it is necessary to smooth them carefully with a sharp knife and sandpaper.

When the surface of the frame has been finished, the edges may be painted with



When the wallboard has been cut out and decorated, the print and back are glued on

black, gold or silver. Some frames will be improved by painting an unobtrusive but decorative design on them with artist's oil colors.

The picture is merely glued to the frame and backed up with cardboard, which is also glued. A wide board then is placed over the frame and heavy weights are piled on it. Allow at least twenty-four hours before removing the frame, which will be found perfectly flat.—HAROLD JACKSON.

RECENTLY I desired to carve my initials on a tool chest. In looking for artistic letters to copy, I came across a sheet of embroidery initials intended to be transferred to linen by means of a moderately hot iron. I discovered that these designs, which may be purchased in fancy goods stores, can be transferred perfectly to oak and mahogany.—A. S. J.

Making Ship-Model Blocks

(Continued from page 105)

cut off. The rod serves as a handle.

If you prefer, you can drill the block at this time. I do this on the smallest size of block, but for the larger sizes I hold them with a spring wooden clothespin, in the jaws of which a partial impression of the block has been burned.

My preference for the strap is soft brass wire except on the smallest block. After the hole is drilled and the strap bent on, I dip the finished block in bicycle enamel, shake the excess off and dry for forty-eight hours, or hang in a tin can and set on a radiator for six or eight hours.

If you happen to know a good blacksmith, you can have the dies made in the form of a spring set, similar to the old bullet swages used by Kentucky riflemen for making round bullets "slick" after they had been molded.

What Do You Want to Make?

IF THERE is anything you wish especially to make in your home workshop or any repairing or painting you need to do about your house, and you don t know exactly how to go about it, perhaps Popular Science Monthly can help you Don t hesitate to write to the Home Workshop Editor

Your idea will, perhaps, form the starting point for developing an article that will help and interest many readers, so please be as definite as possible. Send rough sketches or a picture of what you wish to construct, if you can do it conveniently

Similarly, if you wish to obtain materials or tools which are not stocked by your local dealers and cannot be obtained through any ordinary channels, Popular Science Monthly will be glad to suggest sources of supply.

Look upon the Home Workshop Department as a clearing house for ideas and send in not only questions but also any kinks you have found useful

How to Build a B-Eliminator

(Continued from page 73

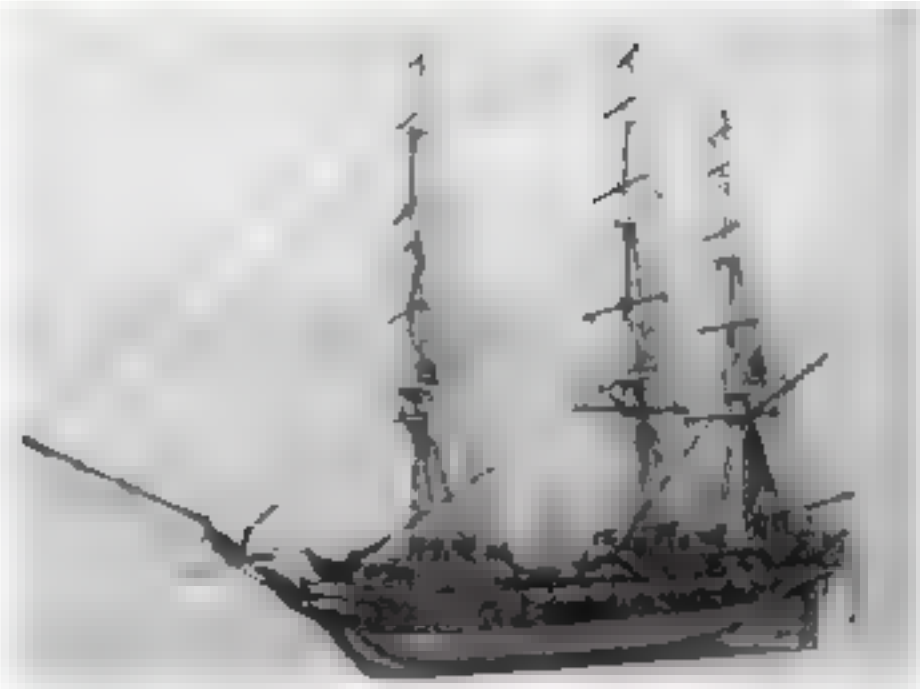
you do not have to think about this point.

To put the de luxe type into operation plug the specified tubes into the sockets and wire the binding posts of the amplifier to the similarly marked posts on your set. When you plug the cord from the eliminator into the wall socket, you will note a dim to re-purple glow in the tubes in sockets K and L. This glow indicates that the eliminator is operating properly Now go ahead and tune-in your set your eliminator will supply just the voltage required without any attention on your part.

While no excess voltages are developed with the de luxe eliminator if you leave it running when the set is turned off it should be disconnected from the electric circuit when not in use to save current and wear on the rectifier and voltage regulator tubes.

The Popular Science Institute of Standards has prepared a special list of apparatus suitable for use in constructing either of these two types of B-battery eliminators. You can obtain this list by writing to the Radio Editor, Popular Science Monthly, 250 Fourth Avenue New York If any details about the construction, wiring or use of the eliminators are not clear to you, include these questions in your letter and they will be answered without charge

Scale model of the clipper ship, *Sovereign of the Seas*, built by John Nichols, of New Rochelle, N. Y., from the plans given in Blueprints 51, 52 and 53. The hull is 20 in. long



"Old Ironsides" in miniature. This decorative model of the U. S. S. *Constitution* is the work of Roland S. Miller, Washington, D. C. (from Blueprints 57, 58 and 59). The hull is 19 in. long

Ship Models Built with Aid of Our Blueprints

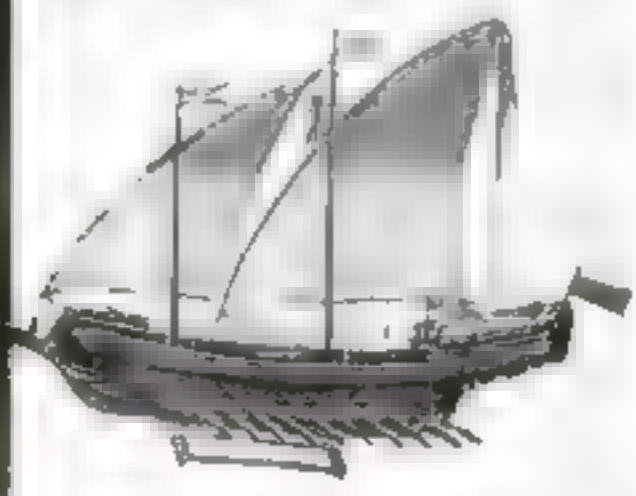
Laurence F. Cashbaugh of Zanesville, Ohio, and his son Ralph, 15 years old, have constructed every one of the blueprint ship models listed on page 203

This Spanish galleon with hull 30 in. long is the work of William Doppermann, of Orange, N. J. Like the other ships on this page it was designed by Capt. E. Armitage McCann, noted authority on marine models, especially for Port and Starboard. More [illegible] see page 201

Pirate galleon. Hit pirates 44 and 45 [illegible] by [illegible] A. Mosser, of Astoria, Ore. Mr. Mosser also has completed a model of the galleon with small figures to represent the crew. **The galleon may be made for $5,' he writes, "but I will not sell my own for $1,000"**

The touch of an artist's hand is seen in the ornate galleon model, which was built by C. V. Czechowsin, of Cleveland, Ohio. He has since built the clipper ship

George M. Wiremuller, of Great Neck, Long Island, N. Y., who is a photographer, built this magnificent model of the galleon



Another pirate model, built by E. E. Brunaker, of Berwyn, Pa. He also has built a second model, the galleon. Indeed, **our readers have done such wonders in model making that we could fill page after page with interesting photographs**

A Cabinet for Your Curios

(Continued from page 108)

design developed through a mathematical analysis of Ancient Greek architecture.

The constructional features are so simple as to bring the project well within the reach of most amateur woodworkers.

First, make the two side frames and bore the holes for the metal shelf blocks or supports, if the shelf is to be movable; otherwise it can be supported on small nickel-plated angles. Next, get out the stock for top, bottom and back—preferably ¾-in. plywood, as it does not shrink. After boring and countersinking all screw holes, glue and screw the top and bottom to the sides; then glue and screw the back to the sides, top and bottom. Care should be taken to get the cabinet perfectly square. After the glue is dry, the edges of the top, bottom and back should be planed flush with the sides.

The frames for the doors are next made and fitted. The rabbet is ⅛ in. wide (⅜ in. deep) because it must hold, in addition to the glass, a fretted panel simulating leaded glass. These fretted panels should be made of plywood, preferably only ⅛ in. thick. The pieces to be removed are sawed out carefully with a coping saw or a fine keyhole saw and the edges smoothed with file and sandpaper. After the doors are hung, the left one is fitted with a flush bolt on top and bottom, and the right one with a small lock.

The top and bottom should be planed and scraped flush with the face of the doors; then the scrolled pieces on top and bottom are glued in place. Sheet-metal screws are driven through the narrow parts of the pieces and small triangular blocks placed behind them reinforce these joints. A fillet ⅛ by ⅜ in. is mitered around the front and sides of the top and bottom and held in place while the glue is setting with very fine brads.

The glass in the sides and doors is held in place by a small quarter-round molding nailed to the frame. The plate glass shelf is supported evenly on four shelf blocks, with a small piece of felt or cork between the glass and each block.

Instead of the turned ornament suggested, a brass ornament, such as an eagle, may be purchased from a firm specializing in metal furniture fittings.

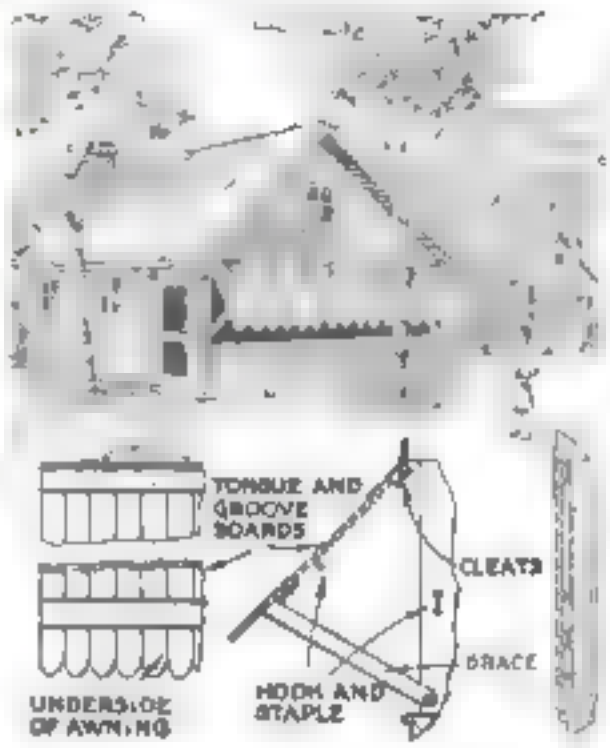
The cabinet is supported by mirror hangers and a strip of 1-in. molding fastened to the wall.

Stock Bill for Wall Cabinet

No. Pcs.	T.	W	L.	Part
2	¾	11	23	Top and bottom
1	¾	9 ⅛	23	Back
2	¾	2 ¾	23 ⅛	Sides
2	¾	2 ¾	23 ⅛	Sides
4	¾	1 ¾	9 ⅛	Sides
4	¾	1 ¾	20 ⅛	Doors
4	¾	1 ¾	9 ⅛	Doors
2	¾	10 ⅛	18 ¾	Doors
1	¾	6	2	Top scroll
1	¾	3	2	Bottom scroll
4	¾	⅜	10 ⅛	Fillet
1	¾	9 ¾	23 ¼	Fit to glass shelf
2	¾	2 ¾	23 ⅛	Wood to glass sides
2	¾	10 ⅛	18 ¾	Window glass doors
2 (pair)	¾	1 ½	1 ½	Hinges
4	¾	¾	¾	Brass with cork
4	¾	¾	¾	Shelf blocks

All dimensions are in inches except as otherwise noted.

Combination Awning and Shutter for Bungalow



Wooden shutter for a bungalow porch which also serves the purpose of a cloth awning

ON THE South Shore of Long Island the "bungalafers," as they sometimes call themselves, have evolved a combination awning and shutter of wood for inclosed porches. It is made as shown, of 3 or 4 in. wide tongue-and-groove pine boards, and painted to look like a cloth awning. When the bungalows are closed for the winter, the shutters are closed and fastened. MALCOLM MACDONALD.

Making Garden Hose Washers

Guide for cutting washers off the hose

TO MAKE washers of any size and thickness to fit standard garden hose couplings, cut slices from the hose itself or from an old piece of hose of the same size by the method illustrated. The guide is made by boring a hole through a block of wood. Cut with a wet knife and then scale off some of the outer rubber. V. OSWALD.

Replacing a Broken Glass Knob

WHEN a glass knob breaks or pulls out of the metal socket, the sharp edges of the socket are apt to lacerate the hand. To make a temporary repair until a new knob can be obtained, roll up a compact wad of paper slightly smaller than the original door knob and press it into the metal socket. Cover the paper with friction tape and sprinkle liberally with talcum powder to prevent stickiness. H. S.

Paper and tape serve as a temporary knob

The Shipshape Home

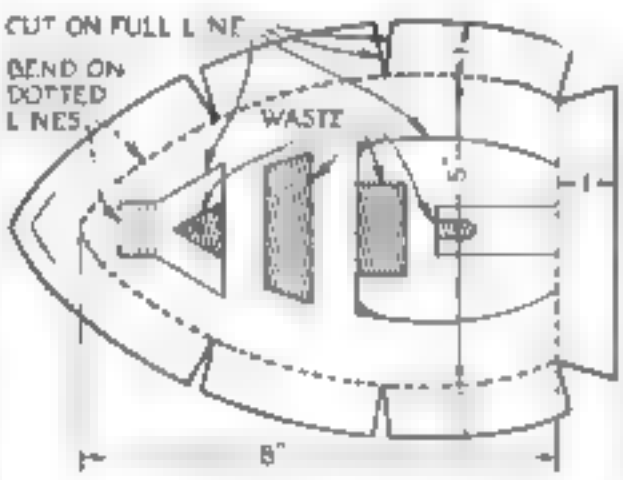
Iron Holder and Stand

THIS simple one-piece electric iron stand illustrated serves two purposes. It is a convenient rest for use on the ironing board, and, when the ironing

The stand used as a rest for the [illegible] and as a holder for hanging up on the wall at the

is done. It is easy to bend over the vertical part into a holder by which the hot iron may be hung up comfortably on a cupboard.

It will be noted that the bent parts of the stand which form its feet, act as clips for holding the iron in place when the holder is hung on the wall. There is also a hook to receive the coiled electric cord. —GEORGE D. HEGG.



By an ingenious method of cutting and bending, the holder is made of one piece of metal

Tightening Loose Casters

FURNITURE casters which, because of age or defects, have a tendency to fall out of tables, chairs, beds, and the like, may be made to hold by wrapping a rubber band around the shank. Rubber is better than string or friction tape because it is soft and pliable and has a high coefficient of friction. —W. F. S.

Simple caster repair

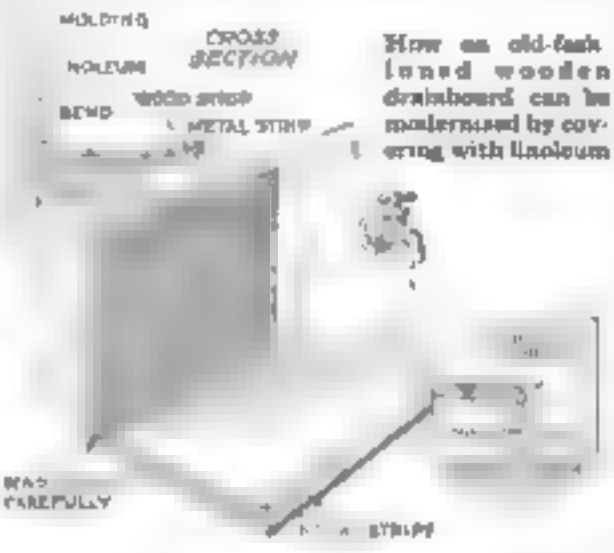
The Shipshape Home

Linoleum Drainboards

INLAID linoleum may be used to cover wooden drainboards, and will give years of service. A remnant 1 yd. square will cover a good sized board.

The linoleum may be bent and carried up the wall to which the board is fastened so as to form a continuous water-tight covering of all surfaces subject to the splashing of dishwater.

Before the linoleum is placed, a strip of wood about ½ in. thick should be nailed face down around the outer edge and end of the board. A few—the fewer, the better—galvanized or copper



How an old-fashioned wooden drainboard can be modernized by covering with linoleum

nails with washers under their heads hold the linoleum in place. The edges of the drainboard also may be covered with a narrow strip of linoleum, giving the effect of a solid slab of composition material.

To cover the cut edges of the linoleum on top, a strip of brass or aluminum, such as used for the edges of automobile running boards, will be found suitable and inexpensive. On the edge of the drainboard next to the sink, the metal stripping should be *under* the linoleum so that water cannot seep under and leave a damp place. It is, indeed, possible to eliminate this joint by bending the linoleum carefully over the edge and nailing it as suggested in one of the accompanying views. The finished covering should be given two coats of first class varnish.—O. K.

Puttying Sash Lights

WHEN replacing broken window panes or reputtying sash, be sure to notice whether the glass rabbet requires a coat of paint or linseed oil. If the old putty flaked off by itself, it is a certain indication that the rabbet should be repainted before attempting to putty in the glass. Putty will not stick permanently to unpainted or unoiled wood.

Glazing is often avoided by handy men because it seems difficult to make the putty lie smoothly. A little trick that will help the amateur is to dip the putty knife in water. Then it will slide better over the putty and leave a smooth surface.

Use only the best grade of commercial putty or mix boiled whiting, a little white lead and boiled linseed oil. Cheap varieties of ready-made putty often contain marble dust, coarse whiting and adulterated linseed oil, and will not last.

This seal on a radio, tool or oil burner advertisement signifies the approval of the INSTITUTE OF STANDARDS. See page 6.

New Ways to Paint

(Continued from page 73)

How a stencil brush is used to pounce one color on another in producing a stipple

all around being in any tint that will set off the black panel attractively. An oriental transfer pattern is used.

These are typical methods of decorative treatment. Compare them with the corresponding illustrations on page 73.

Brushing lacquer is generally used for the finishing because it is easily applied on small objects of this kind and dries quickly.

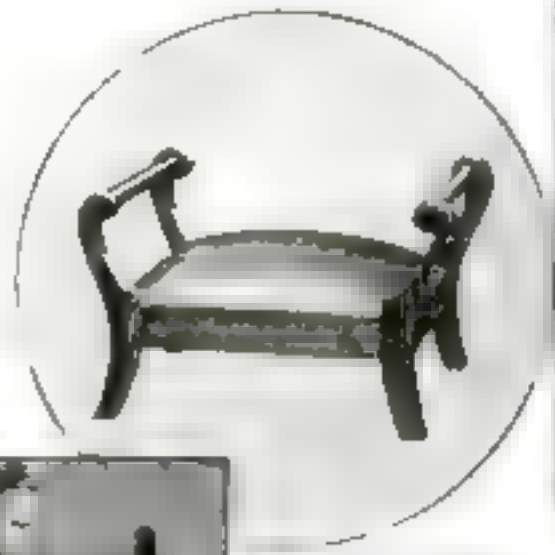
As wooden articles are not generally smooth enough for fine finishing, the surface should be sandpapered with the grain of the wood to as nearly absolute smoothness as possible. Use very fine sandpaper—No. 00 or No. 0000. Dust off clean.

If the wood is whitewood or poplar or any very soft wood, it is a good idea to apply a coat of shellac, which seals the surface and keeps the lacquer from sinking in. On this foundation two or three coats of lacquer will produce a first-class finish. There is another advantage in the use of a priming coat of shellac. The grain of many woods is raised by the application of painting materials, and when shellac has been applied directly to the wood, the raised fuzz may be sandpapered off and the surface restored to a perfectly smooth surface before any lacquering is done.

Apply the lacquer with a reasonably soft brush such as a fitch or bear hair brush—not a hard, coarse bristle brush. Do not keep brushing it, and do not spread it out thin. Work quickly and use a full brush at every stroke, without scraping most of the lacquer off on the edge of the tin. Do not sandpaper between coats unless you use very fine waterproof sandpaper, wet with water.

Combed Stencil Effects

PAINTED stencils as used by amateur decorators are apt to appear somewhat hard and a bit too regular and uniform for the most artistic effect. This can be overcome with the aid of a painter's graining comb containing teeth not more than 1/16 in. wide. As soon as the stencil color has been applied and before the stencil is removed, the comb is drawn over the stencil once lengthwise and once crosswise. This gives the wet paint a texture somewhat resembling a fabric and relieves any appearance of harshness or too great regularity.—J. M. T.



FOOT STOOL
See LePage's Book, page 23.

END TABLE WITH BOOK TROUGH
See LePage's Book, page 22.

HANGING BOOK SHELVES
See LePage's Book, page 21.

BACK REST
See LePage's Book, page 24.

Handiest tool in your shop

Perhaps you have never thought of the special advantages of using LePage's Liquid Glue. It is always ready for immediate use. No mixing, soaking or heating is required. The joints are as strong as the wood. It sets quickly enough so that you have plenty of time to place the parts together exactly as they should go. Slow setting allows LePage's to penetrate the wood and develop the strength of the joint. LePage's Liquid Glue is equal in strength to any animal glue. Buy a can for your work shop. It is the surest, quickest, handiest form of glue. Insist on LePage's.

How to make attractive Gift Furniture

LePage's NEW Home Work Shop Book will show you how

NOW with the coming of fall and the home work shop season, comes this NEW LePage's Home Work Shop Book to show you how to make 20 different pieces of gift furniture, designed by an expert—attractive, artistic, useful, practical and easy to make.

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The first LePage's Home Work Shop Book published a year ago, proved so popular that, though advertised only a few times, over 30,000 copies were sold—an unprecedented demand for a book of this kind. Now the new book just off the press, represents a wonderful improvement over the old one. Of its 20 complete projects, 15 are entirely new and never offered before.

Each project is presented in three parts—a photographic illustration of the finished piece, a mechanical pencil drawing of its parts and simple, easy to follow directions, for making, given step by step from start to finish.

Designed by Expert

For each of the 20 gift furniture projects the design, dimension drawings and photographs as well as the actual articles were made by William W. Kemble, Instructor in Woodworking, Central Commercial and Manual Training High School, Newark, New Jersey. Assurance is therefore given that each project and the directions for making it are perfectly practical.

In addition to the four pieces illustrated above the projects include the following: Table with side flaps and two drawers, Spanish Ship model, folding sewing screen, flowery stand, tilt top table, piano bench, footstool, Priscilla sewing box, Cedar Chest, Smoking, dinner table desk, desk chair, card or console table, book stand, turned bench, dressing glass. Where else could you get complete directions for making all these things for only 10 cents?

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Just write your name and address on the coupon below, tear it out and mail to us today with 10 cents in coin or stamps, and we will at once send you a copy of LePage's New Home Work Shop Book, postage paid. Address LePage's Craft League, 556 Essex Ave., Gloucester, Mass. Tear out the coupon now so you won't forget it.

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City State

LE PAGE'S GLUE

BOTTLES, TUBES, CANS

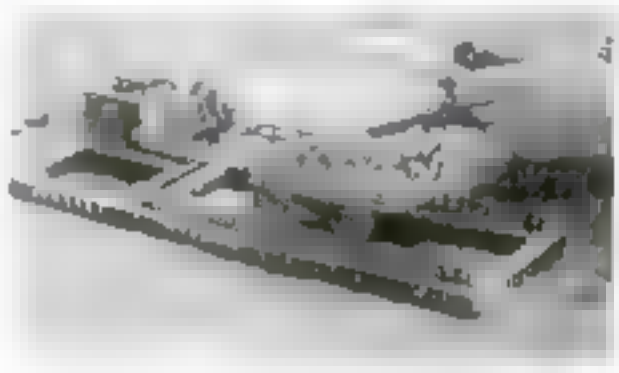
Home Workshop Chemistry

Simple Formulas that Will Save Time and Money

AMMONIA is a colorless gas primarily obtained as a by-product in the manufacture of coke and illuminating gas. Water absorbs about 700 times its volume of this gas at room temperature. As a rule a ten percent solution is known as a concentrated solution. Since it is one of the fundamental chemicals, it may be obtained even in grocery stores.

Large quantities of ammonia are used in the household for cleaning purposes because it acts on grease. Household ammonia may be prepared by dissolving 5 oz. soap in 1 pt. water by heat and adding 2 oz. concentrated ammonia. To make the solution cloudy add a pinch of potassium nitrate.

Floor wax, to give a polished surface to floors, should be applied in thin coats and



A laboratory rocking device made of toy parts and used in this instance to churn a soap solution for household ammonia

rubbed well in with a weighted floor brush. When a good grade of commercial floor wax cannot be conveniently obtained, a wax may be prepared by dissolving 4 oz. beeswax in 1 pt. turpentine with the aid of heat until the wax melts. Remove from the heat and add 3 oz. of ammonia and about 1 pt. of water. Stir vigorously until the mass is creamy.

A varnish which will withstand the action of ammonia fumes may be prepared by dissolving amber in raw linseed oil at a temperature of 300 deg. C. Heat the linseed oil to this temperature in a sand bath and place a thermometer in the oil. Then add the crushed amber and stir until dissolved. Cool the solution and thin with ozonized oxidized turpentine. Such a varnish is useful where the ammonia process is used in freezers.

Use this head as a reminder

Ammonia
NH_4OH

Keep ammonia in glass-stoppered bottles. Rubber stoppers may be used but these swell on continuous exposure to ammonia. Keep in cool place, as heat tends to drive the gas out of the water.

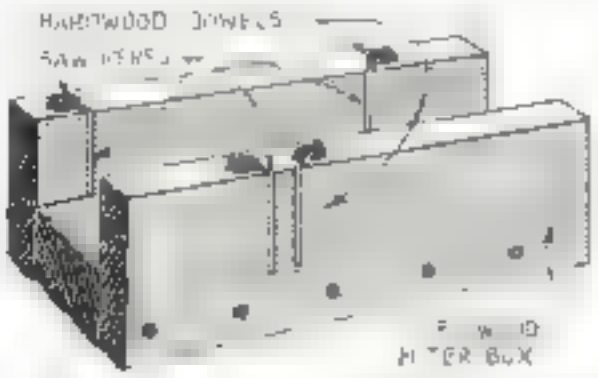
Ammonia will remove grease and, unlike other cleaners, any surplus is dissipated by decomposition and evaporation.

A floor wax may be made by dissolving 4 oz. beeswax in 1 pt. turpentine and adding 3 oz. ammonia and 1 pt. water. Stir until creamy.

If household ammonia consists of 2 oz. concentrated ammonia to 1 pt. thin solution of soap in water and, if desired, a pinch of potassium nitrate to make the solution cloudy.

How to Prolong the Life of a Wooden Miter Box

A WOODEN miter box will last longer and allow more accurate work to be done if holes are bored where the saw cuts



Hardwood dowels are inserted just where the saw kerfs are to be cut in the miter box

are to be placed and hardwood dowels are glued into them, as illustrated. When the glue is hard, the guiding saw kerfs are made vertically through the dowels.—IRVIN L. MOSKOW.

Adding a Room to Your House

(Continued from page 84)

effervescence on the cement, we scraped it off and washed the surface with a solution of zinc sulphate and water—three pounds of zinc sulphate to a gallon of water. When the walls were dry, we applied three coats of concrete building paint, tinting it to match the wall paint used on the wainscot. For the first coat we thinned the paint with about twenty-five percent of turpentine, and each coat was allowed forty-eight hours to dry.

"Then there remained the woodwork—window frames and sashes, doors, stairway and also the radio cabinet, benches and tea cart which had been delivered to us unpainted. These were done in enamel. For the first coat we used flat wall paint of a sage green color similar to the enamel that was to follow. For the second coat we used half flat wall paint and half enamel, and for the finishing coat, enamel.

"For the floor we used concrete floor paint—three coats, the first being thinned liberally with turpentine. It was given a final finish with floor wax. And that is about all there was to it," she concluded. "Our card club had its meeting here last night, and everyone thought it was a wonderful room."

We agreed heartily with this verdict.

"It is a wonder," I said, "that more home owners who have reasonably large, dry and airy basements, don't try to do something with them. If there are boys in the family, the basement can be made into a comfortable and attractive place for them to work and play."

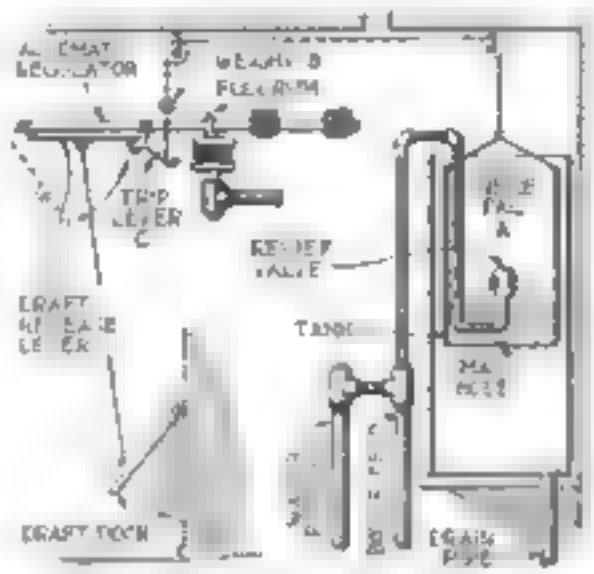
"Yes," rejoined Mrs. Andrews, "when you are hard pressed for an extra room, the basement is the place to look."

MANY times it is necessary to cut down a cork to fit a bottle or plug a hole. A smoother job can be obtained by rubbing the cork over a piece of coarse emery cloth than by attempting to cut it with a knife. If a hole has to be made through a cork, a good tool is a sharp piece of tubing.—RUSSELL W. FOWLER.

Draft Regulator Protects Boiler

By P. T. Satz

AS A protection for the boiler of a high school heating plant, an automatic draft regulator was installed as shown below. Such a device would be a valuable addition to any similar plant where there is danger of a mishap occurring while the engineer is attending to duties away from the boiler room, or, indeed, as a protection for the boiler of a low pressure heating system. This installation was designed after an accident happened. A fuse blew, the electric boiler feed pump stopped, and all the water



If the feed pump fails, pail A fills with water and causes the draft door to close

evaporated and wasted through the air relief valve when no one was watching the boiler. As a result, the crown sheet cracked.

When the feed pump fails to operate for any reason, the water now backs up the return lines until it escapes through the air relief valve of the heating system. If as much as a quart of water escapes into the small pail A, it overbalances the weight B and trips lever C which releases the draft door so that it shuts.

A very small hole in pail A allows the water to flow out slowly after the draft has been closed. Weight B raises the pail, and lever C can be again hooked up.

Milling Cutter Acts as Guide in Drilling an Index Plate

RECENTLY I was given an order to make as cheaply and quickly as possible a 5½-in. index plate with 44 holes for experimental work. Variations of .015 in. on the entire circle would be acceptable.

Plate with milling cutter clamped to it

First I found in the tool crib a milling cutter that appeared to be a good milling job and was of the right diameter and number of teeth. Then I turned the

(Continued on page 117)

Milling Cutter Acts as Guide

Continued from page 116

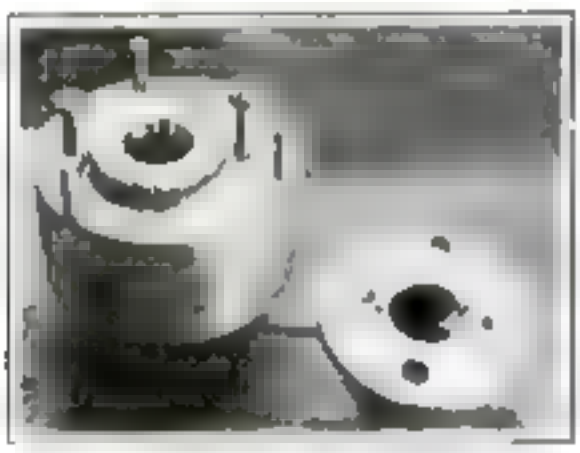
plate and clamped both together on a short ¾-in. stud. I set the combination on two parallels on a small drill press and, using the bottom of the teeth as a guide, located the holes with a center drill.

The milling cutter was removed and the plate drilled with holes of the proper size. Work indexed with the plate was tested and the variation was found to be only .007 in.—H. C.

Simple Shop-Made Chuck for Hole Grinding Operations

IN THE illustration is shown a finished circular stamp, the hole of which had shrunk so that it had to be ground out. To hold it a chuck was made that has since proved practically indispensable.

Two pieces of machine steel, one 4 in. in diameter and 3 in. long, and the other



The grinding fixture with disk removed to show how the work is located and held

3¼ in. in diameter and ½ in. thick were turned, bored and finished on their faces. The main member has three equally spaced ⅜-in. pins for keeping the disk concentric. In the disk are two small pins to hold the work as the screws are tightened. Two headless screws placed in the two extra holes serve the same purpose when work with a larger hole is held.—O. S. MARSHALL.

Uses Old Automobile Motor for Building Hoist

FROM a discarded automobile motor which cost twenty dollars and other parts worth less than five dollars, plus twelve hours' work, I constructed the

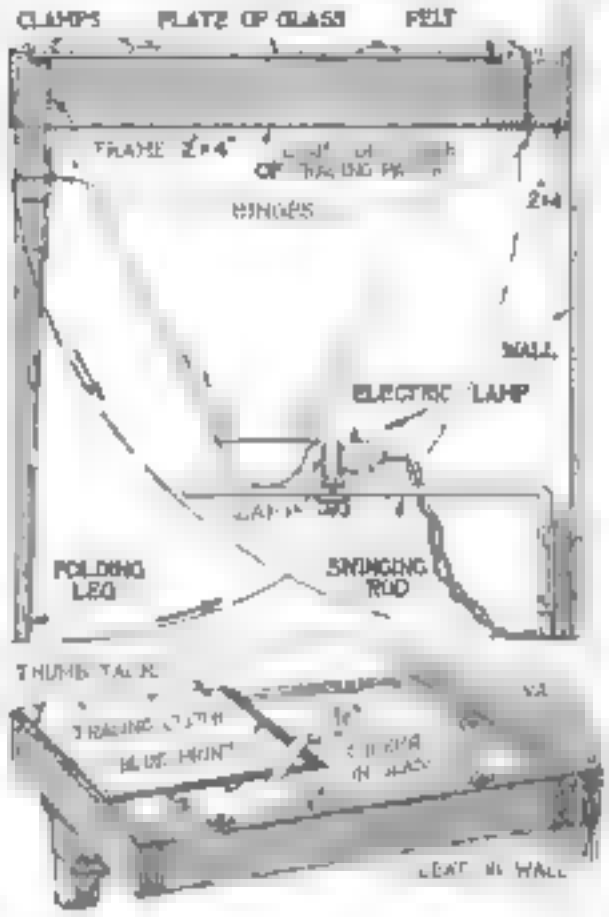
Constructed at a cost of $35, this hoist is used to pull coal in cars up an incline

hoist illustrated. This cost did not, of course, include the rope.

The hoist has been used to pull coal in cars up an incline as well as for other purposes.—C. E. WALTON.

Illuminated Table for Tracing Blueprints

TO MAKE a tracing on either cloth or thin paper from a blueprint, especially from a blueprint that has been made from a pencil drawing, is always difficult. The work becomes relatively easy, however, if the blueprint is laid out on a sheet of glass and thus muted from below.



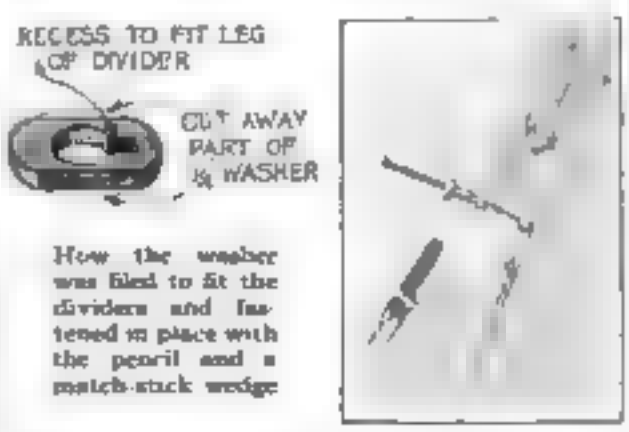
Sectional view and sketch of the top of a shop-made table for difficult tracing jobs

A glass table for this purpose was built in one drafting room, as shown in the accompanying illustration. A sheet of transparent paper was tacked beneath the frame to diffuse the light. The size and method of construction of course, can be varied to meet individual needs.

F. L. Greene, Jr.

Pencil Holder for Dividers Made from Washer

RECENTLY when I lost the elaborate pencil attachment ordinarily used with my dividers, I made another from a washer as shown. A notch was filed inside



How the washer was filed to fit the dividers and fastened in place with the pencil and a match-stick wedge

the washer to fit a leg of the dividers and part of the outside circumference was filed off to reduce the size of the attachment. It is held in place by the simple expedient of wedging a bit of match stick tightly against the pencil.—F. B.

Compact Angle Iron Rack Holds Great Many Tools

THE tool rack illustrated is used to hold a large number of tools such as hammers, tongs, and wrenches over a small floor space.

It is built of angles, the posts being 2 by 2 in. and the other members 1½ by

A rack 6 ft. long and less than 7 ft. high used as storage place for 2 tons of various tools

1½ in. The cross angles are double, with a space between to receive tool handles. The slots are staggered so that long handles hang down between the slots of the row beneath. Between the uprights is a space that may be used for crowbars.

The dimensions of the rack will be determined, of course, by the space available and the tools to be cared for. That in the illustration is 6 ft. long and less than 7 ft. high, yet it holds more than two tons of miscellaneous tools, including more than 1000 hammers.—O. H. K.

Simple Method of Indexing Welded Gear Teeth

WELDING shops not equipped with milling machines or index centers will find the kink illustrated useful for laying out teeth on gears which require some of their teeth to be replaced with welded metal.

A short piece of rod that fits the tooth space is held in two clamps on a surface

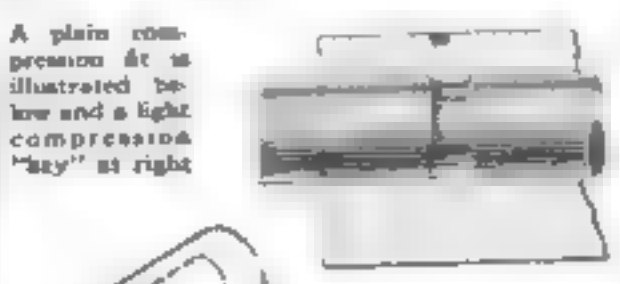
A rod held in two clamps on a surface plate aids in indexing new teeth on a welded gear

plate. The gear is rested on the plate and on the rod. The surface gage is set to the center line of one of the good teeth, after which the gear is indexed so that another space rests on the rod. Then the surface gage may be used to scribe the center line of one of the teeth to be cut.—H. M.

How to Obtain a Light Driving Fit Quickly

CAREFUL work and considerable time often are required to get the dimensions just right for a light driving fit in order to obtain the desired amount of friction. In many cases the expense of obtaining such a fit is inordinately high.

One method that will solve the problem in a good many instances is illustrated below. It cannot be applied where the outer piece is hardened or has a considerable wall thickness, but there are innumerable cases where it can be used to advantage. It consists in compressing



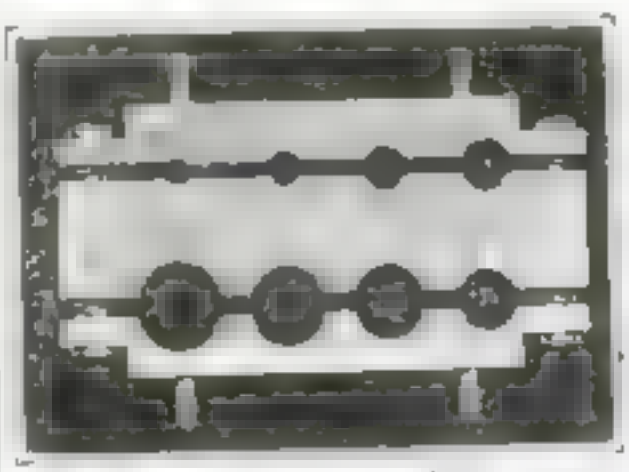
A plain compression fit is illustrated below and a light compression "key" at right

a small portion of the outer part down upon the internal piece. This can be done easily in a vise by using a stout nail set with a large point or a pin punch with a slightly concave end. The heavy pressure concentrated upon the small surface so compresses the metal locally that the pieces are held firmly together.

The same method can be used to key two pieces together by providing a groove in the internal piece of a width equal to or slightly less than that of the point of the tool the displaced metal thus being pushed into the groove. In either case the hold can be increased by compressing the metal at several different points.

This method can be used wherever the thickness of the outer wall does not exceed ¼ in. It can be applied to work having even thicker walls by first drilling a hole until between ⅛ and ¼ in. of wall is left and then applying the pressure.

Clamp for Holding Small Round Finished Parts



A tool used in the vise for holding parts which require to be filed, threaded or slotted

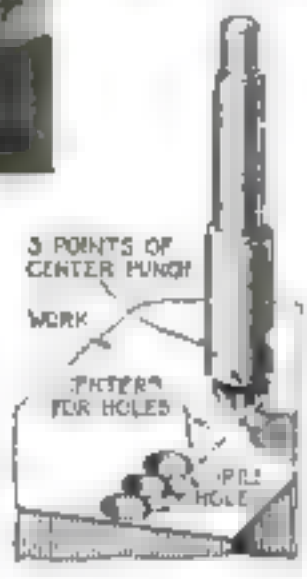
THE tool for holding small round finished parts, illustrated above, is ¼ by 2 by 4 in. with holes from ⅜ to ⅝ in. in diameter. After the holes are drilled and reamed, the plate is sawed in three sections with a ⅛-in. saw. The ¼-in. holes at the ends are counterbored to ⅝ in. diameter and ¼ in. deep to receive the springs.—H. J. C.

Triple Center Punch for Laying Out Dies

WE HAVE used center punches with two points for some time on die work. Still better is a punch with three points by its use the scribing of one line may be avoided

The illustrations show the manner of

Center punch with three points, which saves time in marking the centers of holes to be drilled close together in a die for removing the waste metal core

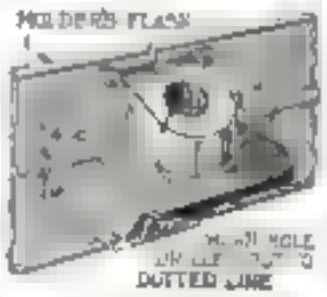


laying out holes preparatory to drilling out the center of a die when using the three-point center punch. The punch is held with two points on the line and struck lightly, making three marks. It is then turned to bring the inner point on the outside line. As one point remains in the mark previously made by it, the tool, when struck again, makes two additional marks. This process is repeated all along the line

To make the tool, three small center punches are required. They must be exactly alike and hardened and ground all over. These are forced into one end of a sleeve, and a rod is driven into the other end so as to touch the upper ends of all three punches. H. Moore.

Welding Torch Used to Bush Holes in Foundry Flasks

FOUNDRIES specializing in high class castings must have flasks with accurately fitting pins, or else there will be an objectionable offset on the castings. Small steel flasks are frequently used for this work; however, in time the pinholes must be refitted.



Flask hole to be repaired by welding

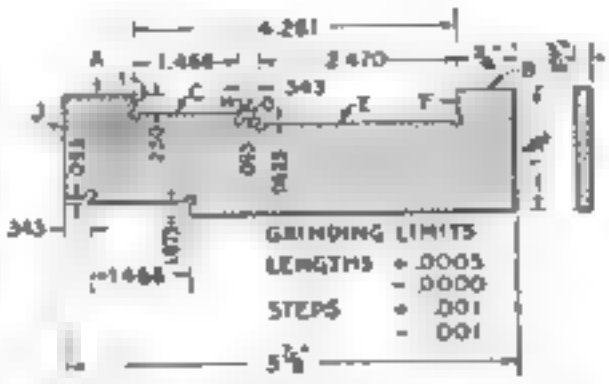
Rather than bush these holes, one foundry found that it could ream out the pinholes and fill them up solid with steel or bronze welding rod more economically. Afterwards a new pinhole is drilled in the welded metal.—V. S. JAMESON

AN OLD piston ring, if slipped over line shafting in a shop will move from end to end and scrape the shaft clear.—GLENN L. BROWN

This seal on a radio, tool or oil burner advertisement signifies the approval of the INSTITUTE OF STANDARDS. See page 6.

System in Surface Grinding

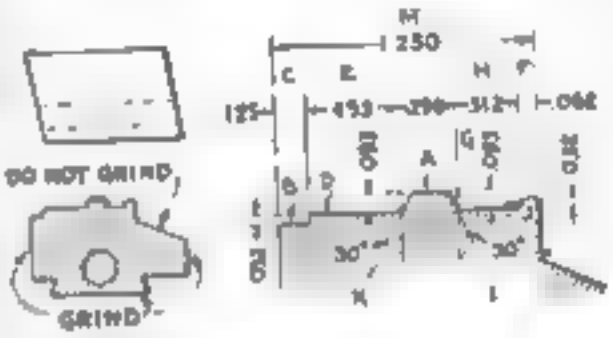
Continued from page 781



The steep gage selected as an example of the problems encountered in surface grinding

centered, and both ends hardened. Then they are ground cylindrically straight and finished to the exact lengths in a V-block.

The operator should study his drawing and check up all dimensions for stock, as removing too much off one side may have some effect on the dimensions near by and perhaps spoil the gage. Each length should be ground a snug fit to the rod and slightly stoned to the proper finish



This dovetail forming tool involves the additional problem of grinding angles exactly

The procedure in this case is as follows After grinding the thickness of the gage so as to have a parallel surface to start with, the regular gage grinding wheel is mounted and dressed as described before. Do not stop the wheel, if it can be avoided, once it is ready for grinding.

As indicated in the drawing of the gage, the top A-B is ground first, then steps C D E, side F is merely squared up and the 2.470 dimension is finished at the opposite side. By retaining the measuring rod in position and using a plug gage, the .343 dimension is finished from H. Next, side I is ground until the 4.281 dimension is obtained. If these three lengths are correct, evidently the length 1.468 is also. The other side is ground as previously outlined after squaring end J. Naturally, when grinding small surfaces such as H, one must feed very lightly.

Dovetail forming tools, although made of specially selected steel, will be changed more or less through hardening. It is necessary, therefore, to grind them all over

The correct wheel is absolutely necessary, as sharp corners must be maintained. The wheel must be of a very fine grain, hard enough to stay sharp but still not heat the tool in the least. For high speed steel tools a 100-J is satisfactory, as no more than .001 in. should be removed at a time. In close quarters it is often necessary to feed downwards instead of using the cross-feed. The amount allowed for grinding should be about .006 in.

A dial indicator is used for taking the depths; the widths are measured with plug gages. In this case a wheel ⅜ in. wide is used. It is advisable to dress the wheel after grinding each dimension so as to have square corners at all times. Before beginning, however, the bottom and two sides of the form must be squared up with a 60-G wheel and the form checked for stock on all dimensions.

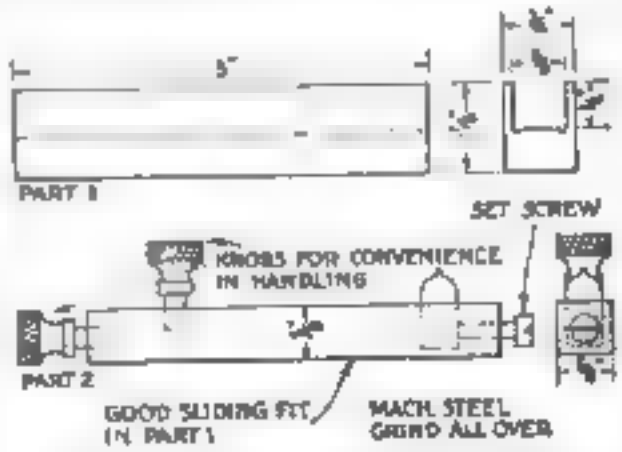
As shown in the drawing of the tool, the top A is ground first, removing .006. Depth B and width C are finished next, then depth D and width E. F is then spotted on the inside and the wheel worked downwards to the proper depth G. In feeding downwards, no more than .0005 should be removed at a time. Depth G and width H are finished and the top of F ground to the correct step (J). In grinding depths D and G, measurements are taken from A.

The two angles now remain to be ground. An illustration on page 78 shows how the angle is formed on the wheel. If a wheel has already been used for this purpose, it should be used again, if available, to reduce the cost. The wheel should be wide enough so as to have ¼ in. flat after forming. The fixture used, which is shown in detail below, is set at the proper angle with the protractor. It should be as nearly as possible radial with the wheel

When the dressing operation has been completed, the wheel is dropped so that it comes barely in contact with depth D, and is worked towards angle K until the flat surface left by grinding width E is removed. The wheel is then reversed and the angle touched up again by clamping the fixture upwards at the same angle.

Angle I is now finished as previously outlined. The forming tool is next laid on the side and the total width M is finished from what is the right-hand end in the drawing. This last operation also finishes width F. If all dimensions are ground exactly, including both angles, the top and bottom dimensions of the angular section should be relatively correct.

Another article by Mr. Chamberland on the surface grinder is scheduled for early publication.



A tool used for forming angles on grinding wheels. It is illustrated in use on page 78

Blasts That Saved a City

(Continued from page 82)

Great Northern Railway completes the Cascade bore in Washington, it will be the longest railroad tunnel in the western hemisphere 7.79 miles from portal to portal. Here two crews in a bore eight feet by nine feet race toward each other, one recently making a world's record of 1,157 feet, almost four city blocks, in thirty-one days.

Every second, somewhere in this country, twenty pounds of explosive is fired. Sometimes it strikes back at those who make and use it. It must be treated with respect especially during the processes of manufacture. The base of dynamite, for example, is ordinary glycerin. When this is mixed with nitric and sulphuric acid, heat is formed; even a slight jar would set it off. The operator glues his eyes to the thermometer until mixing is completed. Even more hazardous is the separating process, done by two men in an isolated house, surrounded by earth barricades, to which the nitroglycerin is run in lead-lined troughs. Here the mixture can be agitated with compressed air to cool it. The men who carry small tanks of this mixture in so-called "angel buggies" break no speed laws. It becomes explosive by shock when forty percent or more is mixed with wood pulp, cornstarch, cotton or other cushioning elements. Straight dynamite, the most shattering, is the most sensitive, containing ninety-two percent of nitroglycerin.

THE mixing is done under roller wheels. In the packing house an automatic machine tamps the brown, sugary mass into paraffined shells of paper, and twenty-five to fifty pounds are placed in a box. One large plant ships sixty million pounds annually. Dynamite produced today will withstand zero temperature, and dangerous thawing is eliminated.

The normal hazard of making dynamite, Charles S. Hunter, a technical expert, told me, "compares favorably with that of other large industries. But an accident in a dynamite factory naturally makes more noise." Millions of pounds are mixed, beaten, washed, moved, shaken, tamped and transported safely.

Dynamite even goes to sea, I was informed by Mr. Russell. "As much as half a million pounds have been shipped to South America on a single ship, with no special precautions beyond packing the boxes close together and labeling them. Not long ago a cargo of potash caked in the hold of a ship was dynamited loose—perhaps the first such instance in history. In the sea lanes dynamite is often used against small icebergs and derelicts. A Newark, New Jersey, shark-leather concern tried hunting sharks with dynamite, using raw meat for bait. The first shot brought a dozen large sharks to the surface, dead, and dynamite is now used exclusively. Whalers use a 'killing lance' with a small explosive in its tip.

Nor are mosquitoes immune from this universal weapon. New Jersey salt marshes are drained by ditches made with dynamite.

EMERGENCY or unusual uses of dynamite often save lives and property. Snow on high mountain passes has been removed. Huge cussions have been jarred into their holes by small charges. Nuts and bolts have been removed from tight places in machinery, wells have been shot, and others made to flow more freely. Woodchucks, prairie dogs and gophers have been killed. For certain pictures dynamite furnishes smoke screens, shell fire and artificial geysers.

Drilling oil wells, especially dry ones, costs fortunes; a well reaching down two miles may cost $500,000. The use of dynamite in the oil fields, however, removes much of the risk.

Truly, dynamite is the modern genie of the bottle, willing to burrow in the earth, lift rock under water, even quench roaring fires, at the bidding of its masters!

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SONG Poem Writers. Address, Broadcast, 256 W. 56th Dept. 126, New York.

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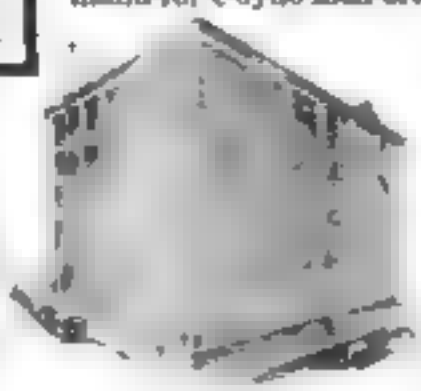

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Typewriters and Supplies

Wanted

America Takes to the Air

(Continued from page 11)

Leaving out the purely military aviation fields, operated by the Army, Navy and Marine Corps, there are thirty-one fully equipped airports now in operation. These are equipped with revolving beacons to guide the flyers by night, with partial or full equipment of flood-lights for landing, flood-lighted buildings, boundary lights and danger lights, as well as necessary hangars and other buildings, oil and gas tanks and staffs of mechanics.

That is a pretty substantial beginning toward the establishment of national airways. But airports are not all that go to make up a modern airway. There must be beacons all along the route, indicating not only the route but safe landing places; and other means of aiding the flyer to keep on the course in fog or storm, such as radio direction finders.

More than 2,500 miles of our national airways system are already completely lighted. By November 1, the Department of Commerce announces, another 4,800 miles and more will be similarly defined for night flying. That is essential; for if aviation is to be merely a daytime affair there is no such great gain in time and speed of communication as to warrant the effort to compete with the railroads.

THE airways now completely lighted are those from New York to Boston, 200 miles, New York to Salt Lake via Chicago, 2,041 miles, and Chicago to St. Louis, 278 miles. The airways to be lighted before the end of 1927 are those from Jacksonville to Atlanta, Atlanta to New York, Chicago to Dallas (via Kansas City), Cheyenne to Pueblo, Chicago to Twin Cities, Salt Lake to Pasco, Wash., Los Angeles to Salt Lake, San Francisco to Salt Lake, and Los Angeles to San Francisco, a total of 4,815 miles.

And the Government's program of airway development does not end with the list of airways now being lighted. Look at the map. The airways defined there are only a beginning.

It works out this way, the Government's new policy for the encouragement of commercial aviation. A city or a group of individuals or some civic organization like a Chamber of Commerce learns that the community wants to be a station or terminus on an airway. Sentiment is aroused and land is set aside or purchased for an airport. Then the Post Office Department is prevailed upon to promise air mail service from the nearest point at which air mail service is already in operation. The Post Office advertises for bids for carrying the mail by air between these two points. These mail-carrying contracts are the American substitute for the Governmental subsidies which have been chiefly responsible for the great development of commercial aviation in Europe. Over routes between populous centers between which considerable commercial business is exchanged, the volume of air mail may quickly be built up to a point where the charge for its transportation will cover the operating costs of the air line, leaving the revenue from passengers and express matter as the basis for possible profit. And the Post Office helps in every way, as by advertising and the placing of air mail boxes at convenient points, to develop the business for the contractors. In Europe mail-carrying is a minor consideration of commercial aviation, in which very little mail is carried.

EIGHTEEN air mail contractors are now either carrying mail over established airways or awaiting the completion of airports and intermediate lighting before beginning operations. You will find the routes of these mail lines on the map on pages 10 and 11. And over most of these airways passenger lines will be running before the end of 1927. Last year only six of the airway lines carried passengers; there are seven regular

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America Takes to the Air

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passenger routes by air operating now, and five more have been announced for early installation of passenger service.

One can ride for an average cost of fifteen cents a mile over these airway routes. From New York to Boston, 220 miles, the fare is $30. To fly from Cheyenne to Pueblo, Colorado, 2[illegible]0 miles, costs $45 for the round trip. For the flight between Seattle and Los Angeles the fare is $13[illegible] each way. Between Salt Lake and Los Angeles round-trip air tickets are $1[illegible]0. Only one air line so far sells commutation tickets, that is the line between Detroit and Grand Rapids, on which one can buy a ten-trip book of tickets for $100. Over the Chicago-Twin Cities Airway the fare is $75 for the round trip.

ON JULY 1 passenger service was inaugurated over the Chicago-San Francisco air route, and on August 1 the New York-Chicago section of the Transcontinental Airway also began passenger service. Five tri-motored planes are under construction for the service. Each will carry twelve passengers, a pilot, navigator, and a steward. The one-way fare will be in the neighborhood of $400. Four hundred dollars is the price of a transcontinental air ticket; the rail and Pullman fare is $140. But it takes from eighty-seven to ninety-six hours to make the trip by the fastest trains, while the air service flies it in thirty-one to thirty-two hours. For a man whose time is valuable $260 is not a high premium to pay for saving from fifty-five to sixty-four hours.

One limitation of transcontinental passenger service is that as yet passengers cannot be provided with sleeping quarters, and probably few will undertake the strain of a thirty-hour or longer flight, sitting up, even with half a dozen stops en route for refreshment and relaxation. No airplane pilot is required to make these long through flights; they are relieved at frequent intervals as are the crews of railroad trains. Secretary Hoover suggests that an air passenger service starting from New York or San Francisco to overtake the farthest passenger train that can be reached in eight or ten hours may be the first important development of cross-continent air travel. The saving in time would be material and the cost approximately the same per mile flown.

THERE is an American program of commercial aviation which is already challenging Europe's supremacy and which, now that America has at last become air conscious, is certain to make this country the greatest flying nation in the world. For that matter, we are already in that position, in the present availability of air passenger service and perfected airways, so recently achieved. I am comparing America now with any individual nation of Europe, not with Europe as a whole, as the comparison is usually made; for we have more airways, more available equipment and pilots, more facilities of every kind for air passenger service than any one European country has, and with the rush of Americans to avail themselves of these new facilities we shall soon have more people flying from point to point, not as a stunt but as a means of getting somewhere in a hurry, than fly in all Europe in the same period of time. Last year, while 5000 passengers flew across the English channel, 7[illegible]0 went by boat and rail.

Undoubtedly there are thousands to whom the possibility of flying to Boston from New York in two hours and a half, transacting a day's business and flying back before bedtime would easily be worth the $40 or so of extra cost over railroad fare. The best railroad service between New York and Chicago takes twenty hours from station to station. With a plane equipped with even modest sleeping com-

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America Takes to the Air

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veniences a passenger could leave New York with the night air mail at 8 o clock, breakfast in Chicago, spend an entire business day there, leave at 8 that evening and be back at his desk in New York at 9 o'clock the next morning. And it would cost him about $240 as against about $100 by rail.

That, of course, is in the future. But the Pullman Company already has plans for "sleeping planes." And Bellanca, designer of the Chamberlin monoplane, has plans for an American luxury service as exemplified in the "Silver Wing De Luxe" service between London and Paris, on which eighteen passengers, seated in luxurious wicker chairs, are carried in a three-propeller plane at 100 miles an hour and are served with meals *en route*.

LAST year the principal European air companies carried, on regular traffic routes, 140,000 passengers over a total of 12,000,000 miles, with only thirty-five fatalities. The air map of Europe is a perfect network of airways, centering chiefly in London, Paris, Amsterdam, Berlin, Frankfort, Basel, Stuttgart, Hamburg, Prague and Vienna, and with regular services extending eastward to Moscow and southward to Naples and Sicily, with at least one line crossing the Mediterranean to Africa, at Tunis. There are about 30,000 miles in this great European system. And in the last year particularly there have been great improvements in lighting facilities and arrangements at airports for the comfort of passengers. An important development is the increase in express and freight service—a phase of commercial aviation still in its infancy in America. The only important demonstration in America of the freight-carrying possibilities of the airplane has been by the Ford Motor Company, which operates the air mail lines between Detroit and Chicago and Detroit and Cleveland. These lines carry no passengers, but during 1926 carried 1,053,338 pounds of express matter over the Chicago route and 606,107 pounds between Detroit and Cleveland. A total of 8,136 pounds of express matter carried in 1926 between Detroit and Grand Rapids by the Stout company is the only other record of air express service in America.

The American habit of mind in considering aviation has been to compare the airplane with the automobile—as a device primarily for private, individual use rather than as a common carrier. I have tried to point out that Europe takes the opposite view, and that it is the regular, scheduled flights over definite, protected airways which our Government is trying to encourage, and which we must develop to compare our aviation situation favorably with that of Europe. There will always be individual aviators, and their number will increase; but that the time is close at hand, or even within reasonable speculative distance, when flying by individuals will become popular enough to call for aerial traffic cops is seriously to be doubted. But five railroads are already considering extending their service with airplane lines.

AS A matter of history, new inventions do not displace the old so much as they supplement them. So it is coming about with air travel, now in America—as for several years in Europe. The thing we have been talking about for twenty years is upon us. Our young men, emulating Lindbergh, are eager to fly. Our capitalists for the first time see aviation as a practical business enterprise. Our plane builders are giving us better planes than ever, our engine designers more reliable engines. Our airports are established and more are on the way. Our airways are lighted. Everything is set for America to take to the air. And America does.

Why We Mob Heroes

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makes the touchdown brings the whole student body to its feet with a roar. But his exploit is useless. The students don't cheer madly their college professor who has made a lasting contribution to mankind through some abstruse bit of research work.

What is the answer? The reason again is to be found in the primitive source of hero worship. It isn't based on a mental calculation of our idol's contribution to human welfare. It arises from the opportunity our idol's exploit offers us to express morally-balked energies.

Modern life affords few outlets of a practically useful kind to the reserves of emotional power we have inherited. But contests of endurance and physical prowess do bring them out. In a game of tennis you use up more energy than in painting the porch floor. But a hard game of tennis makes you feel fine, and painting the floor tires you.

IN OTHER words, the emotions of the tennis contest tap your energy reserve; and likewise the emotions of watching Lindbergh contending for supremacy with other men and with the elements pleasurably release your emotional reserves.

But had one of the other contenders, Chamberlin or Byrd, flown first, our enthusiasm—and the consequent publicity—would have been something less than it was in Lindbergh's case. To understand why Lindbergh was called "the greatest hero of the age," we may neglect the features of the Paris hop that would have made any one of the flyers famous.

Let's forget the international rivalry, the fate of Nungesser and Coli which harrowed our feelings and dramatized the peril of the flight, forget Lindbergh as a sort of aerial ambassador of good will and forget the thrill to our national pride which came with the announcement of Lindbergh's dramatic arrival. All these things built up the total effect to an unparalleled peak of popular enthusiasm. But there might have been the same had Byrd been the first flyer.

Consider Lindbergh the individual.

Lindbergh is unmarried. The other flyers have families. Women could more easily think of themselves as the possible Mrs. Lindbergh than they could fancy themselves ousting Mrs. Byrd from her rights.

Lindbergh is ingratiatingly youthful. Boys want to be heroic young men. Older men want to be heroic young men. Women want the attention of heroic young men. The whole populace could give vent to a deep desire by self-identification with Lindbergh.

It chances that Lindbergh's personality is just the kind in which we could most gratifyingly picture ourselves. He is the typical American boy. He isn't too handsome, too remote, too polished. He is one of us. He is self-made. He comes out of the heart of the country. He has tinkered with motors. He has been kicked out of college. He has been a regular boy. In his far-flung hop he typifies our own fondest and most secret hopes. He realizes those we long for.

THUS it is contrastingly easy to identify ourselves with him and it is especially pleasant to do so because of the dramatic entry into the race. He swooped into it unexpectedly, on two hops across the continent. When the mile runner comes up from behind and beats the leaders out at the tape, we burst our lungs in cheering. The trailing contender who passes the others in a final grueling spurt thrills us because he symbolizes our own situation in life. We are always trailing somebody is always ahead of us. We long to put forth superhuman efforts and dash into the van. We applaud the man who does it for him we are somehow doing the same thing.

But most important of all, Lindbergh, coming up from behind, flew alone. His backers kept completely out of the picture. We barely know their names. Hence our interest was not divided, as it was in the case of the other flyers.

Now in easily hopping off all alone Lindbergh impressed us as being immeasurably heroic. Not only because he would have no assistance in an emergency, but also because of our unreasoning fear of solitude. Man has never been able to fight nature alone. A man made used to solitude often goes crazy.

Lindbergh flew alone! But in fancy we all flew with him, or rather each of us was Lindbergh, making that flight through fog and darkness in the solitude which we dread, particularly, when confronting the elements. The cave man could fight his battle single handed against a wild beast, but when the thunder roared he felt his helplessness and wanted company. Those of us who fear thunderstorms today are unreasoningly happier if we have company.

THUS, when Lindbergh made it, each of us felt vaguely as if we had come through with him, and pulled off a feat of unique courage. In celebrating his success we were figuratively patting ourselves on the back as we—and less fancifully we were glorying because one of us had succeeded.

As a matter of fact, if Byrd in his polar flight had fallen in the Arctic he would have been more hopelessly lost than had Lindbergh fallen into the ocean where a chance ship might conceivably have rescued him. But Byrd was not alone. It was Lindbergh the freelance, the "flying fool," who fascinated us.

We can't divide our enthusiasms over several people. The returning general must share his glory with an entire army. Even Peary, in his final dash to the pole, had to have support. He took a man of another race, which helped us to concentrate our enthusiasm upon him. But there was nobody at all to share Lindbergh's triumph. Hence the intensity of hero worship that engulfed him.

Once the outburst is over, the hero is soon forgotten. Who was the round-the-world flyers? Who made the daylight non-stop flight from coast to coast? The popular hero must keep "doing his stuff." When Jack Dempsey was champion and didn't fight, the fans turned against him. When he put on the gloves again they rallied around him. Gertrude Ederle, performing in a tank in vaudeville, is not making the financial success predicted. Even Lindbergh's day is already passing.

IN CROWD hysteria over each successive hero, we exhaust the energies which his feat typified, and for the time being are satisfied. Another hero, who represents another of our ideal selves, replaces him. The secret of it all is the innate wish to escape unbearable reality by annihilating time, space and mortality. Lindbergh had his day because he approximated two out of these three desires.

Microphone Beats Ear

WHEN English radio engineers recently attempted to broadcast a night ingale song from a microphone concealed in a thicket they threw the attempt a failure. The seldom-heard birds apparently had failed to perform. But their hosts were quickly dispelled by radio listeners, many miles away, who heard perfectly the song of a bird heard but at the transmitting end. So much more sensitive was the transmitter than the human ear that it was able to pick up a distant nightingale's song without the engineers' knowledge.

Airships 2,000 Years Old!

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invented by the magicians, in their efforts to create miracles, are known to have existed, but no more than casual mention of them can be found. For instance, the diving suit of Alexander the Great, in which he investigated the bottom of the sea, in 320 B.C., is frequently mentioned by ancient historians. But descriptions of it differ. Some claim it to have been a diving suit in which the wearer could walk along the ocean bed, while others have it a diving bell built of glass.

We know that asbestos was worn on the soles of the feet of the priestesses of Diana, in 600 B.C., when they walked over red-hot coals at the annual festival in the Greek Temple of Apollo at Bastabala. We also know that the ancients had a method of fire-proofing wood, never yet rediscovered, and that the priests of most countries were familiar with a secret ointment which protected their bodies in fiery ordeals.

WE ARE sure that the magicians resorted to fumigation to rid their temples of flies. A well-known example of this was in the Temple of Hercules, on Mt. Oeta, Greece, where the gods had been invoked to free the building of pests.

We have read that on Mount Larynium, in the southeastern district of Peloponnese, which was called Lacunia, the feast of Bacchus was celebrated in the early spring, and that ripe grapes were produced in testimony of the favor of the goddess. Now we learn that hot-houses were responsible for that pretended miracle.

And—of interest to this generation—Plutarch, a Greek writer under the Roman Empire, tells us that the physicians of the Roman Emperor Tiberius (14-37 A.D.) were familiar with the use of bitter almonds to prevent drunkenness. The presence of prussic acid in the almond has a sobering effect.

Plows 1000 Acres a Day

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planted, cultivated and harvested at the right time. Engines are faster than men and horses."

Electricity is playing an increasingly important rôle in agriculture. The individual electric plant has found countless farm customers. More and more power lines are being run through the country. Electric motors even for such heavy power requirements as feed grinding and ensilage cutting are not infrequent. Lighted barns spot the countryside at night, and literally millions of hens are awakened early on winter mornings when an alarm clock throws an electric switch, and hop off their roosts to eat food and lay more eggs.

Fewer farmhands are necessary when one man with a tractor can plow four to eight times as much as he could with a team. In 1850 one farmer could handle twelve acres in crops; today he can take care of thirty-four acres. A bushel of wheat under primitive methods required three hours of human labor; now ten minutes suffice.

Other inventions soon will make it possible for still fewer farmers to do the same work. Engineering students at Iowa State College, under the direction of Prof. J. B. Davidson, have nearly perfected a plow that will run *without* any human attention other than to supply fuel and oil. Automatically it crosses a field, reverses, shifts and recrosses. Another maneuverless plow invented by F. L. Zibach, of Grand Island, Neb., and demonstrated at the University of Nebraska, was described in POPULAR SCIENCE MONTHLY for August.

As more farms adopt the proved mechanical advantages of the day, a reduction of at least twenty-five percent in the number of agricultural workers will be possible without reducing food production.

When Neptune Scowls

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appeared leaving no clue as to their fate.

On this night, when the moon smiled down on tranquil water, the captain never left the bridge. Hydrographic reports stated that icebergs were adrift here.

A few minutes after two o'clock the captain's quick eye saw what appeared to be a huge silver cliff arising from the sea. In another instant he realized it was an iceberg that had sneaked upon his course.

He remembered the *Titanic*. He remembered the 750 souls in the berths below. He knew it would be impossible to swing his ship about quickly enough to miss the jagged glacial mountain.

Within ten seconds he had ordered full steam astern, changed his course and headed the *Georgian* straight for the floating terror. They crashed! The vessel's bow caved in as if made of paper. Ice, tons of it, tumbled upon the deck.

THE crew discovered that the upper part of the bow had struck an overhang of the berg which had stuck out, like a balcony. This made a great gash just above the water line. If it had crushed the entire bow, even below that line, the ship still would have remained afloat, as the captain figured, because of the water-tight bulkhead placed about twenty feet aft the bow by the builders for just such an emergency.

The stem of the *Georgian* was driven back forty feet, and two of the crew were caught and killed in the wreckage, but the captain, by steering his craft head-on into the berg, had saved 750 passengers.

The bridge is no place for a slow thinking man when two ships collide. Had the captain of the Ward liner *Segua* thought sixty seconds when his craft was mortally wounded in a collision with the *Bing*, a small freighter off Barnegat Shoals one March night in 1917, Davy Jones would have claimed him and his ship.

The *Segua*, homeward bound, was feeling her way through the fog-blanketed waters when the *Bing* stuck its nose into the liner's stern, tearing a hole big enough for a rowboat to enter. The *Segua* staggered and trembled. Before she was back to an even keel the captain directed the closing of the bulkhead doors of the water-tight compartment just aft the engine room, but the inrushing water threatened to buckle the doors.

BELIEVING the doors would hold long enough to make New York Bay, the captain headed there and managed to beach the *Segua* on the flats on the south shore of Bedloes Island.

Some of the most costly accidents occur not on the high seas but when ships are in friendly harbors. There was the German ship *Hoppenstedt Hackmann*, for instance.

With 180,000 cans of oil she was tied up at her pier in New York taking on the last few thousand pounds of cargo. Then Bang! The wheel of a stevedore's hand truck struck the wheel of another stevedore's truck. Two boxes of inflammable liquids toppled from one of the loads and one went hurtling into the hold. Twenty-five feet below it hit another box with such force that sparks flew. Instantly there was an explosion. The cargo was destroyed and the ship badly damaged.

One would hardly expect a million-dollar accident to happen to a steamship unless by fire, explosion or collision. But that is approximately what it cost the U. S. Government to reconstitute the steamship *St. Paul* after she went down in forty feet of water at her pier in the Hoboken River in 1918.

The Government had just taken over the *St. Paul* for transport service. She was being towed into her slip when 400 men working aboard her noticed a decided list to starboard. The men sputtered for their lives.

Just as the last of the workmen reached the open deck the *St. Paul* keeled over on her side. Her masts and superstructure crashed against the pier, then snapped, and a moment later she sank. The exact cause of the *St. Paul's* capsizing was never satisfactorily explained, although investigations were made.

There are "good dog Trays" in the world of ships, as well as in the canine world. These "innocent bystanders" often are victims of peculiar accidents.

The steamer *Curaca* was one of these unfortunates. On the night of December 6, 1917, she was one of a score of ships in Halifax harbor. Members of the crew were in the forecastle sleeping or writing Christmas letters when the French munitions ship *Mont Blanc* collided with the steamer *Imo*, laden with Belgian relief supplies.

IN THE resultant explosion which took 2,000 lives and wrecked an enormous amount of shipping, the *Curaca's* superstructure was blown away and her hull badly damaged. Towed to New York, she was found to sag eight feet in the middle. She seemed hopelessly broken. But she was too valuable a bottom to give up without a fight.

With infinite patience and skill shipyard engineers set about to straighten her keel. And how they succeeded is well worth passing along to others. When the *Curaca* was placed in a graving dock, care was taken to shape the keel blocks so the ship could be brought back to a straight line keel. A careful survey was taken to make sure that the vessel was over the position as laid out for her. The great problem was to bring the portions of the hull—bow and stern—in perfect alignment so as to allow for a patch over the break.

To relieve the strain on the material as much as possible workmen with torches were set to cut the steel plates at the break in the hull, thus allowing the two ends of the ship to settle toward the keel blocks as fast as the water was pumped from the dock.

After seven and a half hours of pumping the dock was entirely free of water and the two ends were resting on the blocks. The *Curaca* had been brought back to a straight line keel. Shipping men who watched the work on the *Curaca* pronounced it one of the most difficult repair feats ever performed.

The hurricane that visited the south Atlantic last summer, piling harbor craft high upon the sands at Miami and other ports, kicked up nothing more than a little "ground swell" compared to the tidal wave which followed an earthquake that hit the harbor of Paco, Peru, back in '68.

THE *Ilderim*, a double-ended gunboat which had seen service in the Civil War, anchored in twenty fathoms of water, was farthermost from the Paco piers and consequently was the first to feel the full force of the mountainous wave that came in from the sea.

The wave hit the *Ilderim* full on her port side. The chains snapped like strings. The next instant the gunboat was lifted high into the air, to the very crest of the great sea wave, and started on its mad journey inland.

Over the piers she went with a rush and a roar, across and above the waterfront shanties, through the municipal plaza, on and on across the sleeping town like a frenzied leviathan, cutting a tree here, a house top there, tumbling, twisting, turning, until, at last, she was brought up with a crash against a hillside three miles from her original anchorage.

When the waters subsided, almost immediately, the *Ilderim* was no longer a denizen of the sea, but a mute monument to the mighty, and sometimes wrathful, gods of the ocean.

Next We'll See to Paris

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ingenious and original method of scanning.

You will recall that in the method employed to send the face of Herbert Hoover from Washington to New York, the face was scanned by an arc light beam, which swept across it in a series of fifty parallel lines. This was accomplished by means of a whirling disk punctured with a spiral of fifty holes, through which the beam passed.

BAIRD employs not one, but three rotating disks. Instead of sweeping a narrow beam across the face in a succession of lines, he illuminates the entire face with filament lamps of 2000 candlepower. The first of his disks, turning 800 revolutions a minute, contains sixteen lenses placed in staggered arrangement so that each focuses on the photo-electric cell a different section or strip of the face. The lenses are arranged in two sets of eight, dividing the face into eight strips. But interposed between the lens disk and the photo-electric cell is a second disk punctured with numerous apertures and turning 4,000 revolutions a minute. These swiftly moving slots interrupt the light rays from the lenses, and thus have the effect of breaking the image into smaller fragments. To give a still finer grain to the image, a third disk with a single spiral slot rotates at 800 revolutions a minute between the second disk and the light-sensitive cell.

The combined effect of this complicated arrangement of revolving disks is to cause the image of the face to fall upon the photo-electric cell in a succession of tiny squares of light of varying intensity. Instantly the cell translates them into a fluctuating electric current of corresponding intensity. This changing current then is amplified and transmitted.

Picked up at the receiving station, the current is amplified again and led to a tube filled with neon gas, causing it to glow with varying intensity, corresponding to the fluctuations of the current. The light from the tube passes first through a disk with a spiral slot, then through lenses in a second rotating disk. Both disks are exact duplicates and rotate at precisely the same speed as the corresponding disks in the transmitting station. The lenses focus the successive patches of light on a ground glass screen, thus building up and reproducing complete images of the original face. All this is done so rapidly that to human eyes not only does the succession of light patches become a complete image instantaneously, but the successive images themselves blend together into lifelike motion.

AS IN the Bell Laboratories television system, the entire success of this method depends on the perfect timing, one with the other, of the rotating disks in the transmitting and receiving stations. This demands that the motors which drive the disks in both stations be perfectly synchronized. Baird accomplishes this by coupling to the transmitting apparatus an alternating current generator, from which current is transmitted to the receiving station. There it is amplified and controls the speed of a synchronous alternating current motor.

Baird is confident that television service over the sea soon will be established on a commercial basis. Faces, he says, will be flashed across the Atlantic on a wave length of forty-five meters. Of his visit to America, Baird said recently:

"This will be almost the last phase in the development for world-wide broadcast purposes. All that will remain will be the actual perfection of a seen image, which is approaching completion. Improvements which I have effected make it mainly a question of greater power to be able to see a person or scene thousands of miles distant.

A House of 30 Servants

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and percolator are often connected by cord to an overhead lighting outlet, which is a poor makeshift, or to a wall outlet, which is better. In high-class installations there are no exposed cords, the "juice" traveling through the hollow center leg of the table and the outlets being countersunk in the table surface.

The size of wires is even more important. It would seem that we might leave this detail to the building code and to electricians. But the owner who does thus often gets about as much satisfaction as a hungry man who enters a restaurant and asks for "a plate of food." With 110-volt service the ordinary lighting circuit will take care of all small appliances between vacuum cleaner, dish washer, fan and refrigerator. More current is needed for heating and cooking apparatus, which require heavier wire.

EVERY appliance is or should be marked by the maker with its watt consumption. Divide the number of watts in a given device by the voltage and the result is amperes, from which the proper size of wire can be determined. For example, the total load on one circuit is four 660-watt units or 2640 watts. dividing by 110 gives 24 amperes, for which the necessary size of rubber insulated wire is No. 10. Here is a table of wire sizes as prescribed by the National Electrical Code:

Amperes	B. and S. gage wire
2	No. 18
6	No. 16
15	No. 14
20	No. 12
25	No. 10
35	No. 8

Perhaps some one who has no wire gage—and not every electrician has one—will appreciate being told that the wire numbers indicate thickness or diameter in very nearly corresponding fractions of an inch, as No. 8 is close to one eighth inch, No. 10 is about one tenth inch, and so on.

How much apparatus does the Caldwell house contain? About everything you ever read of or saw at an electrical show but everything has its place and the casual visitor hardly notices the difference between this and any other tastefully furnished dwelling. As we enter the living room we glance at a small mantel clock. Is that the right time? It has to be, since the clock is electrical and ruled by Washington. No winding and no setting. It is forever and almost mountonously correct. What is that other little clock? The radio control, which draws out sleep-music and exercises. On the wall is a neat thermometer—of course, a thermostat at second glance—which keeps the house temperature within one degree of the desired point throughout the winter. With clock control the heat is lessened to any point at night and brought back in the morning. A bell tinkles faintly. The hostess picks up a miniature receiver and talks with a daughter upstair. This is an interior telephone that connects the principal rooms and saves steps.

THE dining room has all the apparatus for quick and easy breakfasts with interior phone and music thrown in. The kitchen contains an electrical clock, a fan to mitigate summer heat, a choice of radio earphones and loudspeaker (in two places), electric refrigerator and dish washer, a little machine that does the work of several "slaveys" in grinding coffee, heating eggs, chopping meat, slicing vegetables, mixing batter, making ice cream, sharpening and polishing knives; and finally a large electric range with oven and clockwork attachment. You may put the raw materials of a dinner in the oven in the morning and leave the house for the day. At four p. m. the clock turns on 1000 watts of current. Meat and vegetables are brought to a roasting temperature in half an hour, when the current automatically switches off. Cooking continues for an hour and a half with the heat stored in the oven by walls heavily insulated with mineral wool. When you return home at six o'clock dinner is ready to serve. Take a frozen dessert from the refrigerator, make coffee at the table. The cost of cooking that meal, at a power rate of five cents per kilowatt hour, has been exactly two and one half cents!

"Yet some people say electric cooking is expensive," I remarked.

"Yes, I know of a family that gave it up when the monthly bill ran to fifty dollars," replied Mrs. Caldwell. "The reason was that the servants used the elements on the stove to heat the kitchen. Of course it is expensive to use electricity for heating in that way."

"Can a servant be trusted to manage an electric range properly?"

"OURS have had no trouble. We had a Negro maid who not only did everything correctly, but taught herself, after a year, to make small adjustments and renew any kitchen plugs that needed it."

The current cost for apparatus in general is surprisingly low. That versatile kitchen "slavey" unit costs about half a cent an hour. A refrigerator averages around seventy-five cents a week. An electric fan is half a cent an hour, while a radiant heater or a hand iron uses about four and one half cents' worth of current in the same time. Plenty of toast and coffee can be had for two cents, dishes are washed for half as much, an hour of vacuum cleaning is done for a penny. The larger apparatus, as full size range, refrigerator and kitchen unit, are relatively expensive in first cost while moderate in power consumption. It is interesting to note that operation cost has led to greater efficiency in the electric range, through timing and insulation features, than is found in the ordinary gas or other fuel cookstove. Waste and inconvenience go with cheap fuel.

Heating a house and water in quantity are two things which electricity cannot do with any approach to economy. The Caldwell house is heated with gas used with a steam boiler. It is an absolutely automatic system, noiseless and dustless. It ranks mechanically above oil and just below electricity. Its cost is another story although the owner does not think it excessive compared with the high local price of coal, which he formerly used.

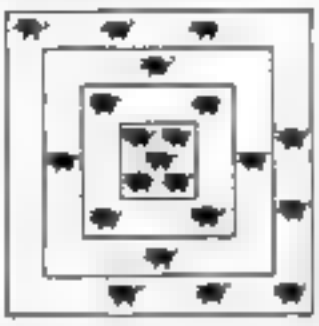
There is a complete electrical laundry in the Caldwell basement and the visitor notices here as elsewhere those little pilot lights which locate fixtures in the dark and also give warning that an appliance is using current, whether a hand iron, washing machine or other device.

SINCE Mr. Caldwell is an amateur astronomer it seems appropriate that he should have fixed up a celestial ceiling for the children's room. Small golden stars dot the blue-white ceiling and constitute an accurate astronomical map with the Great Bear, the Little Bear and all the other sky animals and persons just where they belong. The sun is represented by a large frosted globe light at the wall.

It occurs to the visitor that there may be a minor serpent, as it were, lurking in the electrical Eden. With apparatus, motors and devices galore, there should be quite an item of upkeep and a source of considerable expense. But Mr. Caldwell attends to most of the upkeep himself, spending an hour a month in mending wires, scraping contacts and so on. The vacuum cleaner has a general overhauling once a year. The electric range has needed renewal of heating elements once in four years. A washing machine has been used for eleven years and its total repairs have cost under $25.

Answers to the Sam Loyd Puzzles on Page 65

Can You Pen These Pigs?



The diagram shows how the plucking of one porker from the outer pen and depositing it in the center will present an arrangement which by a little play of the imagination can be made to fit the famous Rory O'More formula, that each pen must contain an even number of pigs and an odd pig.

The central pen containing five pigs fills the bill. Now comes the playful feature of the puzzle as hinted. The second inner pen must be regarded as containing all the pigs within its borders; in other words it contains a total of nine pigs—an even number of pigs and an odd pig. Viewed in the same way, the next pen will contain thirteen pigs and the pen which embraces all the others must be credited with holding the entire twenty-one pigs.

An Arithmetical Courtship

On Sunday, the first day of the week, Kate promised to marry Danny "when the week after next is the week before last." Therefore, if Kate lives up to her promise she will marry Danny in four weeks, or twenty-eight days. Had Danny proposed a day earlier and Kate had made the same reply, then on Sunday, twenty-two days later, her promise would have fallen due.

Moving a Pyramid

The pyramid of cubes may be transferred from Plate No. 1 to Plate No. 2 in 17 moves as follows: A to 2, B to 3, C to 4, B to 4, A to 4, D to 2, E to 3, D to 3, F to 2, D to 1, F to 2, D to 2, A to 1, B to 3, C to 2, B to 2, and A to 2.

A Rebus Memorandum

The sign-maker's memorandum indicated four feet for the reason that it was "3 inches over an L." An ell is a measure of forty-five inches in length.

The Clock Race

Grandfather's clock lost two minutes every hour and the alarm clock gained one minute, so it is evident that the alarm clock in an hour's time gained three minutes upon the other. Therefore in twenty hours it gained 60 minutes. During these twenty hours the alarm clock gained 40 minutes upon correct time, from which we deduce that the race must have started the previous morning at 40 minutes to 12 o'clock.

Insane Sleep in Sawdust Beds

SAWDUST beds for insane patients are the rule at the Eastern State Hospital, Lexington, Ky. According to Dr. William R. Thompson of that institution, helpless patients cannot fall out if the oblong wooden troughs filled to within six inches of the top with fresh sawdust. The beds are comfortable and changing the linen is a matter of renewing the sawdust filling.

Zoo Sells Elephant Hides

SELLING patches of elephant hide is the unusual but profitable business recently established at the London Zoo. The skin of mounted elephants in museums suffers extremely from the weather, and worn-out spots must be covered with patches of the same material. The zoo has just filled a large order for patches to restore the hide of Indarani, an elephant that died a few weeks ago.

Explorers of the Sky

Continued on page 31

balloons" carry self-recording thermometers and barometers to great heights, until they burst. Then a parachute swings the instruments gently to earth, to be examined. "Pilot" balloons carry no instruments; they are watched as they rise by special telescopes known as "theodolites." They show how the wind blows miles above the earth.

In Germany, a sounding balloon reached twenty-two miles before it burst. A pilot balloon soared to a record height of twenty-four miles. This is probably the greatest altitude a man-made device has ever attained.

A projectile from a gun could be shot much higher if the gun were pointed straight up. Havoc would follow its fall. When Capt. Gray tossed overboard a twenty-pound oxygen cylinder, a parachute checked its descent. Otherwise it would have hurtled like a falling meteor through eight miles of space.

ROCKETS may send instruments even higher. Prof. R. H. Goddard, who has proposed to construct a rocket capable of reaching the moon, already has designed a small one to explore the upper air. A Viennese engineer, von Hoefft, proposes also to explore space to a height of sixty miles with an instrument-carrying skyrocket. This seems the only way to reach the upper levels; rockets must get air to fly, depending on their own "kick back" for propulsion. At lower levels, says A. J. Mitchell of the U. S. Weather Bureau, helicopters may eventually replace balloons.

Eight-mile pilots and twenty-mile balloons have already told amazing things about the upper air. For instance, they have found out that our atmosphere is at least a two-layer affair.

You know the "troposphere"—the "ground floor" of the air in which you walk daily. Put on your flying togs, and look at its ceiling. Twenty thousand feet. Time to start taking oxygen. Going up now, and it's getting colder—two degrees for every thousand feet on the altimeter.

Look, now—the thermometer needle has stopped going down. It's cold enough here at 35,000 feet, goodness knows—nearly eighty below—but it's not getting any colder. You're still going up—climbing now into the most exclusive known region, the "stratosphere." The few men who have been here you could practically count on the fingers of one hand—Gray, Macready, Callan, and a few others.

YOU could climb to the "ceiling" of your plane, and it would get no colder; possibly a few degrees warmer. There the thermometer remains stationary regardless of height, though we know it would vary from day to day. And sounding balloons record the same state of affairs up to an altitude of twenty miles or more.

After this "stratosphere," what next? That is where experts disagree. The whole atmosphere extends five hundred miles, or more, above the earth, latest measurements of the aurora tell us. Somewhere, very likely, the stratosphere ends. All we are sure of is that any air above it is nothing like the air we know.

From their studies of the flight of meteors—which first flash into brilliance 100 miles above the earth—the astronomers Lindemann and Dobson conclude that a warm layer of air exists above the stratosphere, starting about forty miles above the earth. Its temperature they put at eighty degrees. Support for this theory comes from an unexpected source. A physicist, F. J. W. Whipple, studying the peculiar way that sound waves from an explosion are often heard better at a distance than near by, found that a warm upper air layer through which sound waves might recurve back to earth would account for this oddity. His calculations place the beginning of the third air layer at only twenty miles high, and give it a still higher temperature.

Again, Abbe Moreaux, director of the Bourges Observatory in France, is convinced the stratosphere ends fifty miles up, and at its top consists mostly of nitrogen gas, the heavier oxygen having sunk toward the earth.

Abbe Moreaux thinks hydrogen encircles the stratosphere. Only traces of hydrogen appear in the air you breathe; the rest may be miles up. Studies of the aurora's spectrum indicate that this is true. This hydrogen might be the warm layer the other investigators suggest.

ABOVE that, from a height of eighty miles up to the five hundred or so where the air ends, we are in the greatest doubt. Some unknown gas, says Abbe Moreaux, possibly the "coronium" observed in the spectrum of the sun, may be here. Dr. L. Vegard suggests that crystalline frozen nitrogen at 330 degrees below zero may encircle the air as a sort of shell.

When Capt. Gray listened to the radio receiving set he took with him on his record flight, he heard clearly music and voices from near-by stations up to a height of 35,000 feet; when they signed off. At this altitude he had evidently not reached the "radio roof" that is believed to reflect radio waves back to earth from some point in the upper air. This was to be expected, for the height of this layer is estimated at forty to ninety miles. Ozone formed by the sun's ultra-violet rays is now thought to cause it by breaking down into charged electric "ions", and its height varies from day to night.

Radio and other mysterious layers—these await future explorers. But there is yet another fascinating possibility in the upper air. The earth may have captive meteors. It is likely, many astronomers believe, that some meteors speeding past our globe were swung out of their course by its gravity and now revolve about us as tiny satellites. One may have been seen.

AT A flying field in San Antonio, Texas, some years ago, Comdr. McDermott, an aviator, noticed an object that resembled a balloon at a great height in the southwestern sky. Through field glasses, the resemblance vanished. The peculiar object had a dark triangular streamer like a shadow pointing to the west. No balloons had been sent up near by; investigation showed; moreover, as far away as New York observers saw a similar object but mistook it for a balloon. The phenomenon remains a mystery.

One of the first altitude flights of any magnitude was that of Gaston Tissandier in 1875. With two companions, he rose over Paris in the spherical balloon *Zenith* to the then extraordinary height of 28,000 feet. Tissandier alone survived, his companions dying in mid-air. He was rendered unconscious.

This was before oxygen tanks were a part of every altitude flyer's equipment. Glaisher and Coxwell, two English balloonists, barely missed death a few years before. At 29,000 feet both became unconscious; Coxwell, fainting, set his teeth in the valve cord and released the gas that brought the men alive to earth.

Many years elapsed before further attempts then, in 1901, two German balloonists, Suring and Berson, startled the world by reaching 35,464 feet.

What new upper-air explorations will disclose we can only guess. The upper void remains still a challenge to daring pilots. New inventions and new aircraft may enable them to go higher and higher still. Gradually, as they skim farther and farther beyond the world, we are learning more about the least known region of all—the upper air.

Schedule or —

(Continued from page 11)

"'Tis that I wish to speak a word to ye about."

"What's the trouble? Still worrying about the engineer?"

"That I am, an'—"

"Isn't there an expert up ahead to ride with the engineer to see—"

"Yes, but 'tis no blood ye can get from a turnip, an'—"

"Oh, nonsense, Marley!" McCutcheon's face darkened. "Hasn't that thing soaked into your head yet? What's become of your native intelligence—and your bearing? Don't you know my hands are tied on this engine proposition, tied with the rope that Sylvester's going to hang himself with? I've been told to let Sylvester handle these trains, and I know as well as you know that he can't. I can't convince the others—but tonight's performance will! Then, when one of the gentlemen higher up realizes we don't need this big-salaried bungler, maybe we won't be bothered with him."

"Yes, but how about the trains tonight? We can't leave—"

"*Leave Bonaventure!*"

Passengers and visitors scrambled up and down the car steps as trainmen gave the signal to start. Marley moved toward the engine like one in a daze.

"Pretty fast schedule for this type engine." Atkins, the locomotive expert, remarked when Marley dragged his weary form [illegible] to the gangway and had slumped down on the fireman's cushion.

Bewildered by what McCutcheon had said to him, Marley sat and stared at the various colored lights as the train clattered out into the seeming tangle of speeding trains and engines in the crowded traffic stream.

"Schedule pretty fast, the man repeated as he clung to the cab window at the superintendent's side.

"Hey? What's that? Fast?" Marley gave him a hard look. "Fast, yer grandmother! Why an engine like this was can—"

"Well, I thought you said, er—I was go on to understand—"

"Tut, tut, Mr. Atkins." Marley was all railroad man now. "Ye can't be payin' no 'tention to switch shanty gossip. Just listen to the old girl bark, an' look at that steam gage!" he shouted above the noise of the labouring engine.

LEAVING Bonaventure Station at 9 o'clock the train bore down through St. Henri and Ste. Anne and finally thundered past Cote-au Junction. Lights of the city behind, the powerful headlight pierced the night haze from the St. Lawrence River and to Marley, the "Frontier Special" seemed to speed along, propelled by its own momentum. Green lights on railside and station semaphores gleamed their messages of a clear track ahead, but those safety signals brought no joy to the superintendent as, with cigar clamped between his teeth, he sat staring into the swift-moving tunnel of light. For Marley was wrestling with the tremendous problem created by McCutcheon's words, trying to fathom the general manager's exact meaning, and at once resisting with all the effort of a man given to viewing every angle of a question, the indirect suggestion contained in those words.

Did McCutcheon mean that failure to make the time with the new train was the end he sought? Would the general manager sacrifice the sacred prestige of the A. & P. Railroad merely to rid the service of a man whom he deemed unnecessary to its personnel?

"Be gar, an' I don't believe it!" he muttered, "I don't believe it!"

But the more he thought of McCutcheon's final words, the

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stronger grew the conviction that he did believe it, that he *had* to believe it.

It was then that he turned his mind to a phase of the problem which never before had been considered. Would he execute Mr. Atkins's subtly communicated orders? Could any man, either general manager or superintendent, be a party to an enterprise designed to cast reflections upon the ability of those charged with the operation of the A. & P. Railroad?

Marley slid the cab window wide open, and with head and shoulders projecting muttered into the night: "An' I will not! Not fer anything will I dirty me record wit' such tricks! 'Tis no change I be makin' in me plans!"

The chilling air stung his flushed face.

"'Tis me job I be losin'," he muttered, and the words seemed to issue from a desolate heart. A moment of silence. Then: "To th' divil with the job which is kept by playin' scurvy tricks."

Having thus set himself right in the matter, he faced the operating difficulties before him in characteristic fashion. Turning to Atkins, who stood swaying in the gangway, he remarked significantly: "'Tis me orders ye will be carryin' out this night—if ye ever expect to ask us anny more favors."

The man gave him a puzzled look.

"CERTAINLY, Mr. Marley, I'm on here to help all I can."

"Then why don't ye be doin' yer own, to smell that burnin' oil?" Marley snapped.

"By George, you're right, sir." Atkins sniffed the unmistakable odor coming in the cab window. "Must be a driving box running hot."

The train was crossing the Beauclette River, which marked the line between Quebec and Ontario.

"Stop at the water crane at the next station," Marley shouted to the engineer. "Be fillin' the tank wit' water while I be speakin' a wurrd to the dispatcher."

"We've got a full tank of water, Mr. Marley; we don't need—"

"Shut up! Do what I be tellin' ye. Ain't all them passengers awake yet? We got to be takin' water, to show what we stopped fer, in case anny o' them gits off to rest."

He turned to Atkins.

"Put a Keeley on the hot box soon as we—"

"We ought to stop right now," Atkins objected. "We may have to put in a new brass, Mr. Marley. That'll take an hour if—"

"'Tis no new brasses we be puttin' in on this train." Marley turned upon him fiercely. "'Tis more instructions I'll be havin' fer ye when I have a wurrd wit' the dispatcher."

When the train slowed for the stop at the water tank Marley swung from the engine and disappeared in the telegraph office. In a moment he reported there, where water hissed from the heated journal.

"Let's go!" the superintendent snapped.

"WE'LL have to change this brass when we get it cooled off," Atkins said.

"'Tis trains ye'll be changin', if ye don't climb on." Marley reached for the throttle.

"But, Mr. Marley—" Atkins swung up the steps of the moving locomotive. "You'll ruin that journal in another ten miles—it'll be cut to pieces if you run it in that condition. These low-wheeled engines were never meant for such fast runs, anyway."

"An' did ye be tellin' them facts to Mr. Sylvester when he bought them?" Marley asked with biting sarcasm.

Atkins threw a surprised glance at Marley.

"I had nothing to do with the sale of these engines. I'm only on here—"

"Save yer breath for puttin' in the brass when I cut the engine out at Lancaster," Marley snapped. "Take it easy, lad." He gave the engineer a slow signal. "To the wheels we wish to be droppin'."

While the "Frontier Special" slipped along through the night, Marley unfolded his plan.

"Put in a new brass when she cools off," he instructed Atkins. "Run her around the wye, so she'll be ready for the eastbound in the mornin'. I'll leave the firebuy wit' ye to help. See the engine is dropped, and wait while the other train comes—she's going back to Montreal on the train that's comin' from Toronto. An' mind ye," he warned, catching Atkins' arm in a terrible grip, "not a wurrd to anny one o' what is takin' place this night."

The locomotive expert gave Marley a quizzical grin but said nothing. The train groaned to an almost noiseless stop opposite a lone engine on a siding. Marley was on the ground, attending steam hose and air pipe between tender and baggage car. Grasping the pin-lifter he gave the engineer a "go-ahead" signal. Driving box now ahead, the new engine was side-tracked, to make way for the 951. Panting from the effort of coupling up the stiff hose, Marley hurried along the side of the tender. Nearing the gangway he paused.

"BE GAR, 'tis a fine job o' paintin' them boys have done!" he muttered happily as the words "Frontier Special" adorning the side of the road engine caught his eye.

On their way again, Marley and the engineer were the sole occupants of the cab of the substitute engine. And as the superintendent felt the handle of the fireman's scoop in his hand a glad cry escaped him. Hour glorious challenge flung back by the walls of a hundred yesterdays sounded in his ears, and as he shoveled coal into the roaring maw of the throbbing locomotive, worry and misgiving slipped from him like the perspiration running from his face.

For several minutes Marley attended his firing. Then he sank heavily to the seatbox where his coat and vest had been thrown, and dragged from a pocket a well-grimed time-table. In the dancing light from the open fire-box door he studied the figures of the schedule. Consulting his watch, he stumbled to the engineer's side to announce: "Fifty-five minutes behind time we be, me lad!"

The engineer nodded. "Yep. I know, Jim, an' I could clean up that time if I had far enough to go; but my run ends at Kingston Junction. West of there you'll have 'Careful Charlie' Jones. Don't see much chance to make Toronto on time."

MARLEY slammed the fire door shut with a violence that caused the engineer to give him a quick look. Leaning against the coal gate he lost himself in troubled thought. He hadn't counted on the possibility of catching an engineer who was afraid to run. He recalled Sylvester's words, now: "when it was too late—if your men are afraid to run—" He wondered vaguely why he had not given some thought to the matter. But he had so few of that kind in the service, the kind that was afraid to run. Jones was one of the few, a stolid plodder who could not be stirred to fast running.

"Careful Charlie," he muttered in disgust. "'Tis no time at all I have fer the likes o' him this night. If I could be takin' this lad through to Toronto wit' me, I could—"

His eye caught sight of the needle on the steam gage and he reached for the scoop. Backward and forward he swung his rugged body as with heaping shovel he scattered the coal upon the broad bed of flames in the furnace. The speed of the train was terrific, and as the engine rounded sharp curves he found a precarious footing.

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upon the threshing apron of sheet iron which covered the space between engine and tender.

"Tunnel!" yelled the engineer.

With a single movement Marley slammed the firebox door and dived for the mailbag just as the train roared into the black pit. Weak and a little sick he slumped, his heart thumping violently. He had forgotten about the tunnel, how the flight of the train into that tube under a short hill would draw the fire through the open door of the firebox, to burn and sear whatever substance it met.

Now that the danger was passed, he commenced to feel the effects of the strenuous toil. His muscles ached from the unaccustomed strain of firing, and his eyes were almost blinded from the glare of the firebox. Hazily he tried to figure the distance to Kingston Junction, where another fireman would relieve him of his back breaking labor. As nearly as he could estimate he had still a hundred miles of gruelling toil before he would be free to surrender his scoop to a man hardened to the work.

"ONLY forty-five minutes late, Mr. Marley," the engineer called as the train flashed through Monkonette. "Means we'll be about twenty minutes late into Kingston, and about the same into Toronto, if you don't have any delays west of Kingston."

"No, we on time we'll be into Toronto," Marley declared doggedly.

"But you know 'Careful' Charlie, the big-head you're goin' to get—"

The rest of the engineer's statement was lost on Marley. For with an excited shout he leaped for his coat, to drag out a notebook. Muttering aloud the words of his message as he set them down, he addressed the train dispatcher:

> Hand up train orders on the fly at Kingston Jct. Frontier Special makes no stop for fresh engine crew or nothing. This crew goes through. Clear line for on time arrival Toronto.

Carefully wrapping the note around a small lump of coal and covering it over with a thin layer of waste, he threw it from the train at Farran's Point.

"Ye're goin' through to Toronto!" he called to the engineer.

"That'd be a violation of the engineer's agreement, Mr. Marley," the engineer grinned happily.

"An' we won't even slow down at Kingston Junction."

"Well, it'll cost you a couple hundred miles pay for old 'Careful' Charlie."

"An' I'm right glad I'll be to pay him—to stay to home," Marley announced grimly.

"It'll be a long hard grind for you, Mr. Marley. It takes a man to fire an engine with a scoop for three hundred miles."

"H'H, an' will ye listen to the lad!" Marley snorted. "Do ye believe I earned the name of 'Mile-A-Day' Marley wearin' kid gloves an' ridin' in a rockin' chair?"

"'Mile-A-Day' Marley will have to become 'Mile-A-Minute' Marley if we land this train on the advertised," the engineer boomed. "An' you'd better load that fire. We'll burn about a ton of lignite on these next hills."

The hours that followed were hours of physical agony for Marley. Painfully weaving on uncertain legs, every muscle crying out in fatigue, even his calloused hands blistered and bleeding from contact with the rough handle of the scoop, he stoked the engine to maintain steam pressure sufficient to meet the demands of an engineer whose soul seemed obsessed with the identical idea which drove himself: that of making Toronto on time.

Then they were entering the yard limits at Kingston Junction.

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The engineer sounded the whistle for the station, to which he added a shrill message for the conductor: "Pick up train orders without stopping."

Down a lane of leafless trees standing stark in the moonlight they rumbled at fifty miles an hour. Leaning from the cab window, Marley hooked his arm through the train order hoop held aloft by the operator. Then Kingston Junction was left behind, its station platform filled with a noisy group of people who had gathered to view the new train.

An hour later a short stop was made at a coal chute. Marley attempted to climb to the top of the tender to pull down the water spout, but he sank exhausted to the coal pile.

"Rest yourself a moment, Mr. Marley," advised the engineer, as he sprang to attend the water spout. "You're about done for."

"Done fer!" Marley shrilled. "Is it spoofin me yer tryin' to do?"

THEY were gliding along again, now to flash by a speeding train on the opposite track with a deafening roar.

"Must have been Number 14," the engineer remarked. "They're right on time. Didn't they have one of the new engines out of Toronto?"

"They did," Marley gasped, "but 'twas no chances I take wit' him, me not bein' able to ride two trains at once. I have the 980 ready at Scarboro Junction, an' make the change there, before they lose much time wit' hot drivers."

"Then they'll change again at Lancaster—pick up the one we left there?" questioned the engineer.

"They will, an' we change at Scarboro Junction, git the wan which they left—which gives the both of us new engines into Toronto an' Montreal, an' Sylvester an' the rest o' them smart fellers thinks they've wint all th' way," he explained.

"Some schemer you are, Mr. Marley," the engineer grinned. "You can ease off a bit on that fire now. We're right on time."

Marley grinned proudly as the train glided along the arrowlike roadbed paralleling the lake.

"'Tis glad I am to hang up the old scoop. But if ivver I become a fireman, John, 'tis fer the likes o' you I'd want to fire," he added enthusiastically.

Scarboro Junction. The success of the run was now practically assured. Hurling in every hand, Marley climbed stiffly from the engine and boarded the locomotive which was to pull the train into the city a few miles distant.

TORONTO at 5:58 in the morning, with two minutes to spare! The "Frontier Special" was now in the keeping of railroad officers of the connecting division.

Then a coal-grimed man dragged his weary body toward the telegraph office.

"An' will ye ask the dispatcher how Number 18 wint into Montreal?" he begged diffidently.

The operator spoke into his telephone.

"Right on time, the dispatcher says," the man replied, "he asks who it is that wants to know."

"Meself, Marley."

"I thought it was you, Mr. Marley," grinned the operator. "The dispatcher says Mr. McCutcheon wants you to call him on the telephone at his home, right away."

So it had come, the call for a resignation that couldn't wait until business hours! Ah, well, he had been between two fires, anyway. If he had failed with the new train, Sylvester would have demanded his pound of flesh. And, now that he had put the two trains across the Ontario division on time, he had defied the general manager. In winning, he had lost. But the victory, (Continued on page 143)

Schedule or—

[illegible]

disastrous as it would be to his future, was not without its sense of triumph. He had kept faith with himself and had safeguarded the sacred reputation of his beloved railroad.

"But 'tis no surprise to me at all, at all," he muttered as he sought a telephone booth. "'Tis what I'd be doin' me own self if wan of me men refused to obey me orders. Be gar, 'tis a job on the section I'll be lookin' for this day," he prophesied, as grimly he gave the number to a yawning telephone attendant.

Marley was clinging to the instrument for support, but when he heard McCutcheon's voice coming to him across the distance he snapped erect.

"Well, Daniel," the general manager began, "you turned the trick."

"'Tis no tricks I be turnin' —an' ye ought to knowed I wouldn't!

McCutcheon's delighted laugh stayed the bitter words Marley would have uttered.

"I MEAN you put 'em over on time," the other explained. "A splendid job you made of it, Daniel. I knew you'd do it, but I wanted to make sure. That's why I said what I did to you there in the station."

"Ye mean ye—"

Marley's weariness slipped from him like a garment. A feeling of happy anticipation possessed him.

"I mean you aren't as slack as you think you are, Daniel," McCutcheon laughed. "You might have known you couldn't keep all those fine plans under cover. I knew all about those engine changes you had lined up. That locomotive expert you had out of Montreal was a man selected by Sir Samuel and myself. Of course, he confirmed what you have been telling me. Sir Samuel has been watching the performance of the two trains here with me. We've been talking over your mile-a-day record in track laying and—"

"Be gar, that ain't nothin' compared to me latest record, mile-a-an'-mile-'n'-a-h—"

"I know," McCutcheon chuckled, "so we've decided that you know best how to run your railroad without Mr. Sylvester and those new engines, so—"

"But, Mr. McCutcheon," Marley interrupted, "keep 'em both, the matt'r o' Sylvester an' the engines too. We can use 'em. Them engines will be fine for mountain service farther west an' I've a hunch Mr. Sylvester would be a grand success in the traffic."

"You think you can get along with Sylvester?"

"Sure an' won't it plenty experience I be havin' in lessons me superior officers?" he questioned joyously.

Roman "Cannon Ball" Found

EXCAVATIONS of the third wall of the city of Jerusalem have unearthed relics of the siege of that city by the Romans, among them a stone ball shot out of a catapult by the Roman besiegers. It also has been discovered that the wall consists of two courses, which were apparently built at different times. It is thought that the lower course was built by King Agrippa, the upper course being added during the war with the Romans.

Grasshoppers in a Glacier

A GLACIER full of grasshoppers is the unusual sight that confronts stray tourists from the Yellowstone National Park at the near-by mining town of Cooke City, Mont. The mile-long snow-covered formation known as Grasshopper Glacier, pure white with blue ice beneath, is filled to a considerable depth with countless numbers of the frozen insects. At times specimens from this novel cold storage are fresh enough for angler's bait.

How Animals Make Love

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up a great foam, all the while bellowing at the top of his thunderous voice. And, as if this were not enough, he menacingly gives off a sickening perfume of musk.

The Malayan lizard sits on a leaf before his mate and sings her a silent love song, while he delights her eye with an exhibition of vivid colors in the pouch which is suspended from his throat. He nods his head and opens and closes his mouth, but never makes a sound.

Because most fish hatch large numbers of eggs at once, few of them have much courtship. Professor Huxley explains. The fiddler crab, a small crustacean which scurries about the sandy beaches and salt flats, possesses one greatly enlarged claw which he uses to flirt with. Professor Huxley has seen a male fiddler stop in his tracks as an eligible young female passed by, raise himself on tiptoe and hold his big claw straight in the air. If the female crab passed, he would run ahead of her and assume his pose again. This flirtation continued until he received some attention or gave up in disgust.

BUT to find the prettiest courtships in all creature life, we must go to the birds. One of the most romantic lovers among them is the bower bird, an inhabitant of the tropics. This esthetic bird starts constructing an elaborate bower, or tunnel, as the mating season approaches. He clears a space and lays a carpet of twigs or moss. Into this floor covering he weaves various colored objects, such as bright flowers, feathers, berries, polished bones, or shiny sea shells brought from long distances. One species of this remarkable bird always mats his carpet with large leaves, their silvery under surfaces scrupulously turned upwards. If wind blows them over he turns them up again, and he replaces the leaves as they wither. Above this artistic carpet the male erects a tunnel, which he weaves from carefully selected twigs. One species of the bower bird uses only delicate stems from the orchid—the most exquisite of all flowers! And still a different species builds a hut eight feet high around a center column gaily decorated with fruit and flowers—such as the bower which gives this astonishing bird its name. The bower is quite distinct from the nest, which is not built until after mating.

When these extravagant preparations are completed, the male preens himself for inspection and stations himself before his bower. He drops one wing, then the other, all the time keeping up a concert of curious whistling notes intended to engage the attention of the female. He also pretends to pick up food, as if the appeal to appetite might intrigue the exacting spouse. Finally, when she approaches, the pair enjoy a hilarious game of hide-and-seek.

THE courtship of the dignified crane, though, is a stately minuet. He wheels around in front of his ladylove making a low bow with his head nearly touching the ground, and ends the first figure by leaping high in the air. He promenades again with a still deeper bow and trails his wings loosely at his sides. His lady then responds with several bows and a hop. Finally the pair execute a series of figures not at all unlike the minuet.

If the cranes' nuptial dance is a minuet, then certainly that of the lesser bird of paradise is a fancy dress ball. The dancing display which these beautiful birds make when they are mating probably is the most colorful in all the feathered kingdom. During the mating season the males perch on horizontal tree branches which are more or less barren of leaves, while the females watch from near by. The ball opens with a vocal chorus of some twenty males, who work themselves into frenzied excitement by shrilling, "Walk-walk-walk-walk-walk," while they quiver their wings. When the music has reached the proper pitch, all the males suddenly lift their wings on each side, raise their tails, and with a quick rustle thrust up and forward the shimmering golden side plumes, which are the pride of the species. For about twenty seconds the males exhibit their superb adornment, rapidly holding their positions and delicately quivering their wings to give a sparkle to their translucent feathers. The show is finished by a mad, excited scamper back and forth along the tree limbs.

MONOGAMY is the rule among birds, at least for one season, or, as in the case of the American wren, for a single brood. The monogamous instinct is frequent also throughout the other realms of creature life, although promiscuity is by no means uncommon. It has been left to the ruff, or fighting sandpiper, however, to establish a society in which the females does the courting. The males of this species at mating time sprout magnificent ruffs or collars, and ear tufts, each male distinctly different from every other. Edmund Selous, European naturalist, tells how he has watched the male sandpipers assemble in a cleared space, known to ornithologists as "the hill." Here they spar and joust with one another or whirl about while alone, but the moment a female approaches each bird drops to the sand, spreads his wings, and remains immobile. The female may find a mate to her liking, or she may preen herself, stroll around, and fly away—on which the cocks arise from the ground rather sheepishly, pretending they have been entirely unconcerned about the whole affair.

In some bird species the females actually fight for their mates. The European warbler is one of these. The males of the species, according to Eliot Howard, English ornithologist, migrate northward a week or so before the females and each establishes himself in a restricted zone, in which no other male is tolerated. Then the warbler begins singing, both to advertise himself to eligible females, and to warn off neighboring males from his territory. When the mate arrives, the two pair for the season. But if two females happen to arrive at once in the same zone, they settle their rival claims by fighting it out. The male hovers by, watching with interest, but never interfering. Neither does he make love to any female until after his matrimonial choice is decided for him.

SONG among the birds, is generally believed to be a love serenade, even though some varieties sing throughout the year. Dr. Ludlow Griscom, of the American Museum of Natural History, however, offers it as his opinion that bird notes constitute a language expressive of widely different emotions.

An ingenious simile on human marriage has been discovered in the wedded harmony practically universal among the birds, according to Charles A. David, American ornithologist. The contented happiness of the mated birds, he declares, results from the unflagging devotion of the male, who never tires of his mate, nor ever fails to save for her the choicest morsels of food throughout the summer, even until their brood is feathered and ready to fly.

Instead of interpreting animal courtships in terms of human behavior, however, Professor Huxley wonders how our own love-making would look to an external intelligence, and asks if it would not be wiser for us to forsake our assumed superiority and frankly interpret much of human behavior from the animal side, rather than the animals' behavior from ours.

Biologists agree that the instinct for procreation of the species is one of the most primitive and compelling motives in all life, and that, after all, there is not much difference between mankind and the insects, including all life between, when it comes to making love.

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a machine shop with which he had been corresponding, run by two brothers named Dodge.

Well, moving in, are you?" was their greeting. "Good enough. Manufacturing too prices on ten sets? Sure, ready in a couple of days. They may call you fellows crazy, but the more the merrier. Keeps us busy. Gosh, we may get into the business ourselves, some day, who knows?

They gave him a tip as to where a deserted carriage factory could be found. On another one of the ribs—the vertical one—was a foundry run by Leland and Falconer. Leland was an expert mechanic, almost old enough to be Gil's father. More drawings and business talk.

"YES, sir," said Leland, "automobiles seem to be catching on. Met R. E. Olds yet? Look him up, he's doing things. We're a little interested ourselves."

"Oh, in that case maybe I'd better take my drawings—"

"Don't let that worry you, Mr. Herrick. We're honest." Gil looked at him again, and knew that he was. "Plenty of room for all of us, I guess. Come here a minute; here's a little plant we're interested in." He led him to a small brick building next door. "Call it the Detroit Automobile Company. Want you to meet our designer, Mr. Ford. Henry, this is Mr. Herrick—"

On another rib, one extending northeast, was an old building that had housed a carriage shop, a frame structure perhaps seventy feet in length that backed up to a railroad. Long and narrow, its dusty floor resounded hollowly beneath Gil's solitary footsteps. Its walls were marked with long-dried streaks of vermilions, blues, greens, and blacks where painters had swiped enamels from their brushes. Not much of a factory, this place, probably more modest than the one Jim Wenden's company was operating, but compared to the barn with its box stall and space for one carriage, it was huge. There was one room at the rear that had once been the paint room. Its floor was an inch deep with dried paint, and it smelled musty and cobwebby. A good place, Gil thought, in which to work out a new idea for two cylinders that had come to him, to begin the more involved construction of a four-cylinder motor that he already had drafted in the rough. There was a lean-to shed at one side of the building; he could use that for his home, until he had a real one. And, because the place was far beyond the car line, in a section that for two blocks was undeveloped, the price was ridiculously low. He bought it, and wrote most happily to Gail. She answered—

ARE you sure you want to come to Boston? Are you quite certain you want to come—after the show? That sounds as though you loved your work the most, to me. It's been four years and more, and you haven't come to see me once. Even your letters have been few and far between. Jim has been here several times. He has changed, Gil. He is not nearly as crude as he used to be. He is friendly and nice, and says nice things about you.

Four years. They can accomplish other things than creation; they can undermine indolence. Does absence really make the heart grow fonder? Mrs. Caswell didn't think so. Not with her methods of subtlety, learned on the day when she broke down in such an unladylike manner and cried before an outsider.

"He has a new transmission, has he?" she would comment when Gail would quote a bit from one of Gil's letters. "That's splendid! How much do you suppose that cost? As much as carfare to Boston? Well, it's time for tea. Or—

"Mr. Wenden and he drove to Elmont and back without a stop? (Continued on page 146)

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Remarkable! That's forty miles, isn't it? How many miles was it that Jim took us the other day?" Knowing full well that Jim had bragged "sixty" and not knowing that he had stretched it nearly double.

There were many such ways, and Gail ignored them all until, as time went on, it became necessary to resist their implications and strive to recall the memory of warm eyes. She knew Gil was working for her and toward her he had told her so many times, on the front porch during those far off days, in the speeding, popping wagon that he had built with his own slender hands, in the letters he wrote—with quite often an apology for being delayed because of a certain mechanical problem that had absorbed him. Was he really in love with her or was it that wagon? That thought finally came and found expression.

YES, Jim had called several times. "In Boston on business," he would say. "Selling stock to some parties here. How'd you like to take a spin, you two? Got an electric outside."

He looked and acted the man of affairs. Just a little crudely, perhaps, but her mother said that she could not outgrow one's farm environment in a day.

"Yes, they're the coming thing, electrics. Gas is too noisy and unreliable," as they purred silently along the thoroughfares of Boston. "Takes an engineer to run a gas engine always will. With this all you have to do is push a lever and steer." It was indeed very pleasant, and Jim was a generous host.

How's Gil?" Still trying to make his wagon go? That's fine! Well, you never can tell. Maybe he'll do it—some day.

Are you sure you want to come to Boston?" Gail wrote. Followed by—"Why don't you take up electrics? They seem to be much more reliable." And Gil with a little factory just beginning to go!

What else was he laboring for but a trip to Boston and all that it meant to him? How could he labor night and day but for the knowledge that she, at least, was sure of him? After the show? Of course! For then he would have a prize to lay at her feet, now, nothing. She, and the job, and the future—all were twisted together like a rope, and Jim was trying to cut it. Why else was Jim calling and saying nice things about him, and disparaging things about his work? Didn't she understand that there was another way of making love besides the one of forcible entrance before a crowd? Gail wrote that, fiercely. As though it were a Jim Wenden to be mastered, as indeed it was.

GIL drove through to New York that November of 1900, in a race that was run alone. It was the hottest, most nerve-wracking contest that he had ever driven. What if there were no actual competitor vying with him? There was a much more threatening, invisible one, always just ahead—Jim Wenden. What if there were no definite prize hung up? There was a vastly greater possible one—recognition by the public, making a market for his first ten runabouts, then twenty, then—. That meant more money, with which he could develop his two, then his four, in a factory so large that it might turn out as many as one a day eventually. On and on those dreams led him. This runabout a thing accomplished, as good as he could make, the next advance was living in his mind. All to one end—Gail.

She had replied to his letter: "All right Gil, but you needn't act so mad about it. Come to Boston—after the show. I'm sorry you can't come before, but you know best. Jim will be here, too, then. He is going to advise us about a trip abroad that mother is thinking of."

Which made him remember the triumphant look in her mother's eye when Gail had consented to return to Boston with her. How could he visit her before the show? This trip through was carefully planned to a schedule. He was taking a letter from the Mayor of Detroit to the Mayor of New York, and planned to arrive on the eve of the show's opening. He was taking a newspaper man along with him, a keen-eyed, alert young man who would write up every incident of the trip.

HIS runabout was as near perfection as he could get it; he was leaving behind another almost finished, and five men and a foreman to assemble the others as rapidly as possible. The original body, as obviously a buggy affair, had been altered to suit this new type of locomotion. Its seat was deeper, its back higher; both were softly upholstered in leather backed by coil springs. The old dashboard was gone. Instead, a slanting prow cut the wind and supplied a storage compartment in which he kept his dry cells and tools. A sloping rear deck concealed two tanks, one for gasoline and one for water, which was circulated through the engine and some coils beneath the floor by a pump driven through a friction pulley on the flywheel. The engine was under the seat, the only visible part of it being the lower portion of the flywheel. Instead of the transverse front spring of the old-fashioned buggy, he had suspended the body on two longitudinal ones, shackling them firmly to the yoke-ended round front axle. The rear springs were practically unchanged. The steering handle he retained, though he had attached a warning bell close to the hand grip where his thumb could find it readily. In the center of the front he had hung the latest model acetylene bicycle headlight. It was a good-looking runabout, save for the box of spare parts lashed upon the rear deck in this instance, and it was in good racing trim.

Cleveland the first day, with a reception committee to greet him when he wanted only to turn up the grease cups on the crank shaft bearings, pour some oil in the crankcase, and go to bed. Buffalo next, with a parade of cars waiting on the outskirts to escort him into town. There must have been fifteen of them, the automobile was beginning to catch on, and there were no electrics! Then the hills and valleys of New York State, and trouble. Cold when they started, it grew colder. The wind whistled against their faces, through their buttoned greatcoats. Dust, then mud, then ice, coated them so that they had to stop and remove their goggles and wipe them off with stiffened fingers. Roads—"thank-you-ma'ams" that demanded almost constant use of the brake which closed on a drum between the two planetary transmission boxes, streams with bridges that either humped high or sagged low, some with no bridges at all. The tires came unglued from their rims and had to be roped on. The ropes cut through and Gail used wire, and telegraphed New York for a new set to be waiting.

EVEN going down hill he had to go slowly, for there was the inevitable humpback or sagging bridge. Going up hill was worse, for the pervasive watershed had to be bounced over. Sometimes at these ridges the engine stalled, and Gil a passenger had to jump out quickly and set a stone behind the wheels, the brake was not strong enough. Twice he broke a spring, and lost valuable time getting it repaired. His front wheels jolted out of line and the axle had to be straightened. But five days later—better time than Winton had made!—he drove into New York triumphantly, to be arrested by a bicycle cop for obstructing traffic!

New York had advanced to the point where one could drive

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through Central Park without being arrested, but it seemed that one couldn't leave a mud-stained vehicle at the curb long enough to change a set of tires without first obtaining a parade permit. Here was where the newspaper man proved to be a friend in need. While the Goodrich men were mounting a new set of tires, he got busy on the telephone and arranged for Gil's release. And during that time Gil was told of a brand-new tire

THE Goodrich people had acquired the American rights for the manufacture of a new type Michelin tire several months before. It was a double tube affair that embodied an advanced clincher arrangement. A rim, shaped in cross section like a double hook, was riveted to the wooden wheels. Into this rim an outer cover for a pneumatic tube was slipped, its projecting edges sliding under the rim hooks and being held there by six V-shaped wedges, the legs of which extended down through the felloe of the wheel and carried wing nuts, accessible between the spokes. After the nuts were firmly screwed tight, thereby wedging the outer tube's projecting edges into the hooks of the rim, the inner tube was blown up with a hand pump, and there was a tire that was practically a part of the wheel. Gil ordered a set complete with wheels, the tires to be three-and-one half inch, asked that they be mailed during the show, and drove away on his freshly greased single tubes to deliver his letter to the Mayor of New York. Another trouble surmounted, then.

Then, with his bones shrieking for rest, he drove his travel-stained runabout, mud and all, directly into his booth at the Madison Square Garden show, and forgot his aches to sit up half the night with a New York business man. The man's hair may have been almost white, his corpulence clothed in a dignity that was almost overawing, but there was red blood in his veins, and all the strain of the five-day trip had not been in vain. He wanted, for delivery the next year, twenty runabouts!

That explained the mood of Gil Herrick when, after four years, he met Jay Jim Wendon the next day. In an aisle-way between exhibits Jim stopped directly in front of him as he had done once before, directing a piratically humorous glance down at him.

"Wonder you'd speak to me," he asked, in a voice that was reminiscent of Zach's, and stuck out a big hand. "Thought you'd be plugging away in that barn for the next ten years."

GIL was surprised. He had not been thinking of Jim at the moment now—was there a pain in his left shoulder or did he just imagine it? Jim looked prosperous in an obvious sort of way. The suit that covered his big frame was of well cut material but a trifle too light and bechecked, his light brown derby was cocked a little; his shoes were brightly polished. Gil, who had been spending his money on other things, was far less impressive. He looked down at the extended hand.

"Guess I won't risk it again," he said with a smile on his lean face, and the hand dropped. "No, I left the barn last spring. I'm exhibiting."

"You don't say so! Well, that's fine! What company you working for?"

Myself. Gil pointed down the bunting-draped aisle to a booth at the end where a sign: Herrick Runabout, was conspicuous above the heads of a crowd. Then he said, quite deliberately: "Who are you doing now?"

Jim stiffened and sobered. "I'm retaining my stock interest in the Consolidated Electric Vehicle Corporation," he said with dignity. "And forming a new company to manufacture a four-cylinder car."

"Well, well, that's fine!" said Gil. "Talking like Wall Street—and (Continued on page 149)

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changing horses in the middle of the stream! The Amalgamated Automobile Company of the World, capital seventeen million dollars, I suppose. With another European engine, may I ask, or are you going to make this one out of paper and a pencil?"

"Look here, Gil—"

"Well, luck on the stock-jobbing. There'll always be suckers," Gil continued, then stepped aside as though to pass on.

But Jim stopped him with a hand laid on his shoulder. "Wait a minute, young fellow! I don't like the way you talk."

Gil shrugged the hand off. "Going to pull some of your muscle bound tricks?" he asked. "Thought you'd grown up. No, you may not like the way I talk, but you started it asking foolish questions. You know what I've been doing without asking. And I know what you're doing, too. Don't forget it. You were going to beat me out with electrics, weren't you? Now you're going to gas. Engines, I suppose, not talk. Well—" he left it unfinished.

JIM laughed shortly. "Maybe we'll get you with Consolidated Electric yet," he retorted.

"Yeah, the Selden Patent. I heard about it. You will control the world, won't you, Jim? Reminds me of some talk I heard once about racing sprockets. Remember it?" and he walked away. To be overtaken by one last taunt.

"Hey, Gil! What's the latest from—"

Gil whirled and interrupted him. "That's something else you know. Answer it yourself."

They met several times during the following week, but only once for an exchange of words. Gil was much too busy in the meantime, joining the newly formed National Association of Automobile Manufacturers, which included parts makers as associates; making a strong talk, backed by his personal experience, upon the necessity of forming an organization to improve the roads, interviewing parts makers, inspecting the many models of all the exhibits. I say nothing of the press of affairs that a man on the verge of success encounters. I pity—

Saturday. The pompous, white-haired gentleman who proposed to sell twenty runabouts had had a conference with his—"associates," he called them. They had come to the conclusion that runabouts could not be sold. The crowd that gathered about Gil's mud-stained vehicle were only curious; they were not buyers. Did the people who looked at a giraffe want to buy one? No doubt the runabout would cover the roads, but look at it—and remember what you looked like on the day you arrived in town. Sorry.

FROM Gil: "We're sailing from here on Wednesday! Isn't that great? Two more excited people you never saw, and mother is so gay! We're storing our furniture, because we don't know how long we'll be gone and we're so excited. Be sure to come and see us off, won't you? That was a wonderful thing you did, driving across the country like that. I read about it in the papers."

And from Jim: "That's a nice four you're working on, Gil," with a twinkle in his black eyes. "But it ain't one, two, three with me."

Could Gil summon one more smile? To have all these things come at once—with Jim announcing treachery in Gil's little plant! This was worse than any hammer lock. But he swallowed, and to add a grin:

"Oh, that? I scrapped that engine. Like to have the drawings? I'll send 'em to you as soon as I get back," and he turned on his heel and walked away.

To find himself standing beside the inclined wooden runway on the roof of Madison Square Garden. How he got there he could not have told, but there he was. (Continued on page 149)

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watching a runabout puffing up and down the imitation hill. A demonstration of hill-climbing ability! It would halt part way up, then start on again; stop on the way down, then up some more. Marvelous—on a road built by hand of nice planks! Suppose that well-dressed demonstrator had to drive for five days on the roads Gil had come over! Well, at that, the man was probably selling his runabout. It wasn't covered with mud. It wasn't a giraffe.

"Say, are you Mr. Herrick?"

Gil turned slowly, and saw two alert-eyed young men with excitement in their faces. One was taller than he, dark and dapper. "My name's Morton, Chas. T." The other was Gil's size, with freckles on his beak of a nose, and red hair. "This is Fred Andrews. Got a minute to talk?"

THAT was about all Gil did have—time. "Yes, I guess so. What is it?" More questions, of course, that all these people had to ask. Giraffes. Well, what else was he good for but to answer questions?

"Let's go down where it's private," said the tall one. "We're not interested in this cotton-padded stuff," with a gesture toward the "hill-climbing" exhibit. Gil perked up his ears. "Got an agency for your runabout in New York?" was what the freckled one asked when they had closed a door behind them. Gil hesitated. To them it may have seemed a moment of consideration, to him it was the time required to swallow his heart—and recall a certain previous offer—before he could speak.

"I'm considering a proposition," said he. Was his voice steady?

"Well, we've been figuring
" read about your stunt and
" overheard what you said about your four
" " looked 'em all over . . ."

They stopped and looked at one another as though to say, "Who's doing this talking, anyway?" Then they laughed. Gil joined them.

"Maybe you'd better take a vote to see who's going to talk," he suggested. The two strangers looked at one another and came to a silent agreement at once. The tall dark one spoke up.

"WE'VE got a little money between us," said he, "and we've been knocking around town looking for some good business to get into. Don't know an awful lot about this automobile stuff, but it looks pretty good to us. With the way these foreign cars are coming in, it looks like we ought to be able to sell a few runabouts next year if we go at it right—and your proposition's good. Say, sob, twenty."

"Twenty!" The way Gil said it would have put the finest actor to shame. It intimated that such a proposition was not worth considering. "Why, you ought to be able to sell fifty."

The tall one looked at the red-headed one, who smiled and nodded in a way that meant but one thing. "See? I told you!" They seemed to understand one another pretty well, those two, though what reason there was for such a nod was a mystery. The dark one nodded assentingly then, whereupon the redhead seemed to bristle with a surge of energy. "Sure," and he with a glisten in his red-brown eyes, "why not?"

A pair of unclenched hands came out of trousers pockets, took a chair and swung it over to where three heads could get close together. "What did you say your names were?" said Gil.

Gil drove another, totally unanticipated race, on Monday. To Boston. He had not intended to drive through; he had planned to go by rail. But out of the conference with the two men of his own age another item of news had developed. Andrews and Morton, as his agents came to be

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known, had tipped him off to a man named Tinsley who was thinking about opening an agency in Boston.

"A young man?" asked Gil.

"Yes, why?"

"This is a young man's business," was all the explanation he would offer. "And say, you made a remark when you were both talking at once—something about hearing me talk about hours."

MORTON looked at Andrews and they both laughed. "Yeah," said the redhead. "We were after you then. You were talking to a big chap and we were waiting to get hold of you. Looked to me like you had him outbluffed, and I told Mort, here, that if you were that kind, we'd better tie up to you. Mort didn't know, but gosh, we had a time finding you! Guess you owe me and Mort then, didn't you."

"Yes," said Gil thoughtfully. "I did." That defiant gesture of a defeated man, it had been observed; and now look! "I'll tell you about that some day. What about this man Tinsley?"

It seemed that Tinsley was a friend of Morton's, a square-shooting chap, hard to convince but ready to listen to reason. He had been unable to get down to the show on account of an illness in his family, and had asked Morton to look around for him. That was what had started him and Andrews. They ought to be able to do the same in New York, they thought, and Tinsley ought to sell twenty five runabouts in Boston if we sell fifty here.

"Thing to do is drive up," said Andrews, seized with an idea. "Big demonstration. Sweep him off his feet. It'll help us, too." His eyes grew brighter as the idea took form. "I've got a friend on a newspaper there. He'll write it up. Headlines— Twentieth Century Methods. Man Versus Miles for Millions. New Era Business Man—all that. See?"

"Great!" said Gil.

THEY had talked nearly all that Saturday night. Prices—"a dollar a pound, and my machine weighs seven-fifty."—discounts, deliveries, all the details involved in the deal. Then he had gone to bed and dreamed, with open eyes staring at the ceiling, seeing a great factory with a procession of runabouts popping out of an open door, long humpings, autings, a power plant, shafting, pulleys, belts, machines—blue eyes, crowned with coils of auburn hair with glints of gold in it, smiling.

"Starting for Boston tomorrow morning," he wired her when he got up from a few hours' sleep, "to give you a real ride and some great news. Better unpack your bags."

Andrews and Morton were gamblers. They staged a send-off that would have done honor to a celebrity, and Gil broke the speed laws as he flew up Broadway. Fifteen, twenty miles an hour, with a bicycle cop hanging on either side of his runabout to make it legal, and a line of machines behind. Wine? No blood ever tingled with artificial stimulants as Gil's did that brisk November morning. The world was his oyster; he would open it and present it, to person, to Gail. The work involved in getting such a production going? The night and day labor to meet a demand for five times the number he had planned for? Nothing with Gail. No Lochinvar ever rode into the East more gladly; no Hercules ever looked at a monumental task with less fear.

Will Gil's fine dreams come true? The rewards of his long struggle now seem within his grasp. Can he clinch them? And what of Gail? After years of separation, will she still feel the same toward him? Next month's installment tingles with romance and dramatic incident.

Here Are Correct Answers to Questions on Page 46

1. The answer to this question is to some extent a matter of opinion. It is probable, however, that the distinction is best deserved by the famous Bay of San Francisco. This bay has anchorage sufficient for all the navies of the world. And once a ship has entered through the narrow Golden Gate, it is protected completely from the waves and winds of the open sea.

2. A number of species of these blind fish have been found in cave waters in various parts of the world. The best known probably are those from the caves in the south central part of Kentucky. One of these caves is the famous Mammoth Cave.

3. This is a growing industry on a number of islands off the southern coast of Alaska. The blue fox, which produces the best skins, will not live in captivity. But on these islands the fox finds itself at home, food is provided, any animal enemies are exterminated and the foxes are allowed to live in the wild state. The sea prevents their escape.

4. These are the famous flat cakes made of corn meal by the Indian women of Mexico. They take the place of bread in the native diet.

5. The island of Porto Rico, formerly a Spanish possession, now a territory of the United States. The translation of the Spanish name, "Porto Rico," is "rich port." This name was given to the island because of the fertility of the soil and the plentiful supplies of food. In ancient Spanish, however, the word for "gate" and the word for "port" were the same; accordingly, the translation "Gate of Treasure" is legitimate.

6. The Amazon, which, flowing through northern Brazil, is more than 3000 miles long and nearly 50 miles wide at its mouth.

7. In ancient times this was supposed to be a great whirlpool located north of the British Isles, off the west coast of Norway. It was supposed that whole ships were sucked down into it. Of course, actually, no such whirlpool exists. However, the sea in this part of the world possesses some strong currents and tidal movements. So there grew up the legend of the Maelstrom.

8. The crocodile lives in the River Nile and its branches. Each crocodile is commonly accompanied by a little bird, called the "zicteac." The bird picks bits of food, parasites and the like off the crocodile's teeth.

9. This name comes from the town of Mosul on the Tigris River in Northern Irak. When the thin cloth known as muslin first was introduced into Europe, it came from Mosul.

10. This is the native name of a priest of Tibet. The head of the Tibetan religion and of all the many orders of Tibetan monks is called the Grand Lama.

11. In the islands of the New Hebrides, in the South Seas, north of New Zealand, the natives frequently build bathlike houses in the [illegible].

12. This custom probably originated in China. Nowadays, small metal images of Buddha or of other gods are made in China and Japan and shipped to the pearling fields of the South Seas. Here divers put the idols into the shells of the living pearl oysters. Gradually the idols are covered with pearl. Years later the oysters are fished up and the pearl-covered idols are taken out and sold.

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